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Perspectives on sustainable food systems and their development in Northern Ostrobothnia, Finland

Doctoral Dissertation

Kirsi Korhonen

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Academic dissertation

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Summary

Discussions scrutinising sustainable food systems began to intensify during the 2010s. Today, the entire food chain is under review, including product life cycles ranging from food production to processing and distribution, and from there on to consumption and eventually sometimes to waste collection or other disposal channels. In the general debate and research, local food and food waste have largely established themselves as their own themes, but they are strongly related to a larger whole and seek to fulfil similar goals – the formation of more sustainable food systems. Both local food and food waste are highlighted in strategies and programmes at several regional levels – European Union, national and provincial, for instance.

Issues related to sustainable food systems may be linked to, for example, local production and its new distribution infrastructures, the availability, accessibility and affordability of nutritious food, and low negative environmental impacts. This dissertation examines regional organisation and management of sustainable activities (related to food systems). I approach this theme by reviewing different sub-areas and their embodiments (local food logistics, consumer food-buying groups and food waste management) as well as their development among different food chain operators (producers, consumers, food service sector) on a relatively small regional level, in the province of Northern Ostrobothnia, Finland.

This dissertation consists of three articles and is based on the method of triangulation. The first article introduces an accessibility method for analysing the potential for integral networking of producers and transport companies with berry production as a case study. The study utilises qualitative analysis and a quantitative geographic information system (GIS). The design and parameters for accessibility analyses were built upon the results of two questionnaires and six interviews. The method can be applied wherever suitable road network and food production data are available. However, in practice establishing these types of activities would require more exploring of suitable operators and business models.

The second article examines and evaluates the characteristics and stability of 'traditional' consumer buying groups – food circles (ruokapiiri) by studying their structure and status changes over a five-year period and reviews their similarities and differences compared to Facebook-based REKO rings. The main data for this study was collected via an electronic survey and seven semi-structured interviews. Additionally, literature was reviewed for the analysis of REKO rings. According to our study, REKO rings seem to have largely replaced traditional food

circles in the study region. Additionally, our study suggests that traditional food circles in particular have had an important pioneering role in Finland, as they have introduced the concept of collective buying and making local and organic food more familiar to the consumer.

Finally, the third article adds information about the amount of food waste and the state of food waste management and, on the other hand, brings up measures which have helped operators in the food service sector (private and institutional restaurants) to reduce their food waste. The main material consists of data from two food waste measurement periods. In addition, supplementary data was gathered via a survey, interviews, and a workshop. Our study showed that a reduction of up to 30% in food waste among food service outlets is possible with relatively simple measures. The most effective ones seemed to regard paying attention to storing of food and placing food waste posters and/or brochures in the dining area.

This dissertation has a practical policy approach to the emergence of sustainable food systems in the study area. This study confirms that a "sustainable food system" is a very multi-dimensional entity. I believe that identification of different dimensions of such systems would be beneficial in the preparation of regional strategies and development projects in the future. In addition, I suggest that areal differences and their potential to implement different international and national strategies should more often be taken into consideration.

Keywords: sustainable food system, local food, food waste management, Northern Ostrobothnia, Finland

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Writing this dissertation has been a long but necessary process in my research career at the Natural Resources Institute Finland (Luke). It all began a decade ago when I started as a trainee in a local food-related project, where I also wrote my master's thesis. I would now like to express my thanks to everyone who has been involved along the way.

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Oulu, May 2023

Kirsi Korhonen

List of original publications

I Korhonen K., Kotavaara O., Muilu T. & Rusanen J. 2017. Accessibility of local food productions to regional markets – case of berry production in Northern Ostrobothnia, Finland. European Countryside 9: 4, 709–728. DOI: 10.1515/euco-2017-0040.

II Korhonen K. & Muilu T. 2022. Characteristics and stability of consumer food-buying groups: The case of food circles. Review of Agricultural, Food and Environmental Studies. DOI: 10.1007/s41130-022-00172-4.

III Korhonen K., Hietala S., Välimaa A.-L. & Muilu T. 2023. Managing food waste in the foodservice sector in Northern Ostrobothnia, Finland. *Submitted on 2 March 2023*.

Author contributions to the articles

	I	II	III
Planning and developing the study design and methodology	OK, KK, TM, JR	KK, TM	KK, SH, A-LV, TM
Performing the study and sampling	KK, OK	KK	SH, KK
Data analysis	KK, OK	KK	SH, KK
Writing the paper	KK, OK, TM, JR	KK, TM	KK, SH, A-LV, TM

Korhonen, K. (KK), Kotavaara, O. (OK), Muilu, T. (TM), Rusanen, J. (JR), Hietala, S. (SH), Välimaa, A.-L. (A-LV)

Article I (Korhonen et al. 2017) is based on the RuokaGIS project (Accessibility of local and organic food in Northern Ostrobothnia, executed in 2012–2014) designed by TM, JR and OK. All authors participated in planning and developing the study design and methodology for this article. KK had the main responsibility for designing surveys and gathering and analysing survey data. KK and OK prepared and implemented the interviews together. OK was responsible for the accessibility analyses and acquisition of the intended statistical data. KK and OK wrote the original manuscript and TM and JR participated in editing.

Article II (Korhonen & Muilu 2022). KK was responsible for planning and developing the study design and methodology for this article. The main data (survey and interviews) was gathered in the RuokaGIS project by KK and a research assistant. A majority of the statistical analyses, as well as the transcription of the interview data, were also done during the project by KK and a research assistant. KK investigated the status of the food circles and reviewed literature for comparative analysis with REKO rings later on. KK wrote the original draft and TM participated in editing.

Article III (Korhonen et al. 2023) is based on the YLIKE project (Utilisation of surplus food as a part of circular economy, executed in 2017–2019) which was designed by all authors and managed by KK. All authors participated in the planning and developing the study design and methodology for this article. KK had the main responsibility for designing, gathering, and analysing survey data, and organising a workshop. SH and KK were responsible for informing food outlets about food waste measurements and planning food waste campaigns. SH was responsible for analysing the data from food waste measurement periods. KK wrote the original draft and SH, A-LV and TM participated in editing.

Glossary

Circular economy	The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended (European Parliament 2023).
Food circle (*ruokapiiri*)	A food circle is a group of people who buy their food together. Products are usually purchased directly from farmers or ordered from special eco-shops or wholesale businesses. Voluntary labour and togetherness are an integral part of the circle (Airaksinen et al. 1999).
Food service sector	All companies serving food (profit and non-profit).
Food system	Food systems are the sum of actors and interactions along the food value chain (IFPRI 2022).
Food waste	Food waste is food and the associated inedible parts removed from the human food supply chain (UNEP 2021).
GIS (geographic information system)	A spatial system that creates, manages, analyses, and maps all types of data (Esri 2023).
Local food (*lähiruoka*)	The production and consumption of food that uses raw materials and inputs of its own region of production and promotes the economy and employment of the region (Maaseutupolitiikan yhteistyöryhmä 2000).
Logistics	That part of the supply chain process that plans, implements, and controls the efficient flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements (Mentzer et al. 2001).
Northern Ostrobothnia	Province located in the central part of Finland.
REKO (REjäl KOnsumtion / fair consumption)	Modern food-buying groups which operate in closed Facebook groups.
Sustainable development	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland 1987). In general, sustainable development includes three core dimensions of sustainability: economic, social and environmental.

Contents

1. Introduction

1.1. Background and research environment

According to Allen and Prosperi (2016), sustainability has become a guiding principle and a main goal for human development. Worldwide concerns such as environmental degradation, social distress, and economic fluctuation are challenging conventional views on development forcing reconsideration of our everyday behaviours. Reports related to rapid climate change (e.g., IPCC 2012; IPCC 2022) and declining global biodiversity (e.g., UNEP 2012; UNEP 2022) have highlighted that policy needs to strengthen the public perception of humanity and nature as interdependent and interacting (Allen & Prosperi 2016). Moreover, recent global (and local) events, such as the COVID-19 pandemic and war in Ukraine, have shown that unexpected situations might have unforeseeable impacts on agriculture, rural areas, food production and food safety.

Agriculture and food systems are at the centre of debates over sustainability, while there are concerns that the traditional agro-industrial food system has not provided a sufficiently nutritious, sustainable, or equitable supply of food (Donald et al. 2010). For instance, according to Tukker et al. (2006) food accounts for about a third of the total environmental load caused by consumption. Additionally, it is estimated that one-third of all food produced for human consumption is lost at different stages of the food chain (FAO 2013).

According to Allen and Prosperi (2016), building sustainable food systems has become a popular motto and a major endeavour to redirect our food systems and policies towards better adjusted goals and improved societal welfare. The food system has a high level of complexity driven by many economic, socio-cultural, and environmental factors, which are both internal and external to its boundaries.) A sustainable food system can be defined as one that: *''provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come, with minimal negative impact to the environment; encourages local production and distribution infrastructures; makes nutritious food available, accessible, and affordable to all; is humane and just, protecting farmers and other workers, consumers, and communities''* (Story et al. 2009). In comparison IFPRI (2022) shortly states that: *ideal food systems would be nutrition-, health-, and safety-driven, productive and efficient (and thus able to deliver affordable food), environmentally sustainable and climate-smart, and inclusive.*

Many studies have shown that de-globalisation of food markets appears as a discourse of alternative food networks (e.g. Renting et al. 2003; Sonnino and Marsden 2006) as well as food system localisation (e.g. Hinrichs 2003; Feagan 2007). Local food and short supply chains are seen as valuable within European Union policies and national implementations and significant efforts have been directed toward their research and development during recent years. The previous EU rural development policy 2014–2020 increased emphasis on short food supply chains and local food (EPRS 2016), whereas the recent Farm to Fork Strategy (EU 2020) aims to *design a European food system that is more sustainable for the planet and for people's health*. In addition, local food has gained share in public procurements, while many EU member states have identified that local food promotes sustainability (European Commission 2012).

Local food has been on the political agenda in Finland as well, especially since 2010. It is clearly recognised as a future growth sector in Government Programmes (MMM 2013; Prime Minister's Office 2015; Finnish Government 2019), and A Government report on food policy (Valtioneuvosto 2010) and the proposal for a national food strategy (Karttunen 2010) promoted local and organic food as separate development areas. The National Local Food Programme (MMM 2013) was seen as a steering instrument in support of the governmental local food policy during the EU programming period between 2014–2020. A new government report on food policy, Food2030 (MMM 2017), was published in the spring of 2017. The report sets out the policy objectives and key priorities of the activities until 2030. The National Local Food Programme was also updated in 2021 (MMM 2021a).

Project activity regarding local food (and organic food) has been abundant. Since 2007, numerous projects have been implemented that cover issues related to local and organic food in Finland. According to a project listing compiled by Lappeenranta-Lahti University of Technology (LUT), there were at least 105 local and organic food-related projects implemented between 2007–2013 (LUT 2014). In the past few years alone, the Rural Development Programme for Mainland Finland 2014–2020 has funded 91 development projects that mentioned 'local food' in their project descriptions (FFA 2020). In addition, a nationwide 'Local Food Coordination Project' was implemented between June 2015–January 2018 which aimed at increasing and intensifying cooperation in the local food industry and enhancing the competitiveness of the sector through networking (RURAL.FI 2020). Furthermore, since September 2018, similar action has been carried out in a nationwide 'Food Sector Coordination Project' (Aitojamakuja.fi 2020a).

Some major topics under discussion regarding local food have been logistics and consumer food-buying groups. It has been identified that in the case of small

producers, lack of competitive logistics and small volumes limit the access of products to markets via centralised flows and it is important that local food producers develop networks with each other (see Piilo 2003; Järvelä et al. 2009). On the other hand, cooperative consumer movements appear as traditional food circles but moreover, during the past decade the Facebook-based model (REKO rings) for selling and distributing local food has emerged and quickly evolved (see Snellman 2021).

On the contrary, the inefficiency of the food chain appears as the vast amount of food loss and food waste. In the EU, around 88 million tonnes of food waste are generated annually with associated costs estimated at 143 billion euros (European Commission 2022). Reducing food waste is one concrete way to influence the carbon footprint of the food chain. If food ends up as waste, the inputs used in its production, the environmental impacts and the costs of its production have been generated for nothing. Reducing food waste is a relatively simple measure that can improve food safety, generate economic savings and reduce the high environmental burden and emissions of food production (Dou et al. 2016).

The importance of reducing food waste has been widely recognised in Europe, and the European Union has announced its goal of halving food waste by 2030 and reducing it 30% by 2025 (EUR-Lex 2014 & EUR-Lex 2018). According to the EU Waste Directive (EUR-Lex 2008) and the principles of the circular economy, the priority is to reduce and prevent the generation of waste. If this is not possible, the waste should primarily be reused or recycled (see European Commission 2022). Also, in Finland's most recent government programmes (Prime Minister's Office 2015; Finnish Government 2019) and several development programmes such as the Finnish Bioeconomy Strategy (TEM 2014, Finnish Government 2022), the Climate Programme for Finnish Agriculture (MMM 2014), Climate-friendly Food Programme (MMM 2021b), and the National Waste Plan to 2027 (YM 2022) have noted the reduction of food waste and the promotion of a circular economy. Retail, food service sector and households have been identified as those parts of the food chain that have the greatest potential to reduce food waste in industrialised countries (Mattsson et al. 2018).

Growing the local food industry and reducing food waste have been an integral part of regional development strategies in the study region of this dissertation, Northern Ostrobothnia (Vuorela 2017; Council of Oulu Region 2014; Onkalo 2013). For instance, The Council of Oulu Region has developed a strategy for the food sector in Northern Ostrobothnia that focuses on developing the local food industry (Vuorela 2017), whereas the rural development plan of Northern Ostrobothnia 2014–2020 (Onkalo 2013) raises food, environment, and climate change among the nine focus areas. In addition, according to the Oulu Region

Bioeconomy Strategy 2015–2020 (Council of Oulu Region 2014) an advanced bioeconomy is characterised by overall material efficiency, including the economical use of natural resources, the efficient use of side streams and the recycling of materials at different stages of processing and consumption.

Based on the above, this dissertation will examine regional organisation and management of sustainable activities related to food systems. I approach the theme of "sustainable food systems" by reviewing its different sub-areas and embodiments as well as their development among different food chain operators (producers, consumers, food service sector) on a relatively small regional level, in the province of Northern Ostrobothnia, Finland. The selected sub-areas (local food logistics, consumer food-buying groups and food waste management) have been more prominent in recent years, both in policy strategies and in public debate. However, comprehensive, multi-input research regarding sustainable food systems has been scarce, and its different sub-areas as well as food chain operators have often been examined separate from each other. In any case, the challenges which are related to the meeting of the supply and demand of local food and reduction of food waste occupy actors in the whole food chain. Also, from a geographical perspective a sustainable food system is an interesting area of research due to its spatial-temporal dimension. Before I go more deeply into the objectives and scope of this dissertation, I will next present the research area in more detail.

1.1.1. Study region

Northern Ostrobothnia is a province located in the central part of Finland between the coast of Bothnian Bay and the eastern border of Finland (Figure 1). It has a population of 415,603 (SVT 2021b) and a total area of 45,851.98 km2, of which land covers 36,829.93 km2 (MML 2022). In 2021, over half (58.9%) of the population lived in urban areas (SVT 2021b), mainly in the provincial centre in the city of Oulu (209,551 inhabitants). The rest of the population is mostly located in rural areas (40.7%) and in the southern half of the region. Northern Ostrobothnia is a growing and developing region; its population is well-educated and has the lowest average age (41.0 years, SVT 2021b) of any region in the country. Northern Ostrobothnia is described to be a region that embodies the whole of Finland, and the city of Oulu is an important regional centre, not only in Finland, but also in the north-eastern part of Europe (Council of Oulu Region 2022).

Figure 1. Location of the research area, Northern Ostrobothnia, in North Europe (Reprinted CC BY image from Korhonen & Muilu 2022, © Authors).

Agriculture and the food industry have a significant impact on the regional economy in Northern Ostrobothnia. Northern Ostrobothnia is also a nationally important agricultural region, although the cold weather and northern growing conditions limit the cultivation of bread cereals, for example. On the other hand, the region is home to Finland's only high-grade seed potato production area (SPK 2023).

In 2021, there were 3,893 agricultural and horticultural enterprises in Northern Ostrobothnia (SVT 2021a), of which the majority were engaged in other plant production or milk production (Table 1). The total area of agricultural land in use was 239,872 hectares, and the average farm size was 62 hectares. The number of

farms in North Ostrobothnia has decreased by 22.4% in ten years (since 2011), which is about the same as the decrease in the whole country (23.3%). The average farm size in Northern Ostrobothnia has increased by 34.8%, which is more than the increase in the whole country (27.5%). The regional structure of agricultural production in Northern Ostrobothnia is strongly dominated by the regions south of Oulu (Kotavaara et al. 2014). In Northern Ostrobothnia, the strengths of raw material production are in milk, beef, potatoes and cereals (Vuorela 2017). The region's food industry relies heavily on domestic raw materials and primary production in the region: the main raw materials are most commonly sourced from producers in the region, from producers outside the region and from domestic medium- and large enterprises.

Table 1. Agricultural and horticultural enterprises by production sectors in Northern Ostrobothnia and the whole country in 2021 (SVT 2021a).

	Northern Ostrobothnia	Whole country
Other plant production	1,678 (43.1%)	17,114 (38.3%)
Milk production	836 (21.5%)	5,015 (11.2%)
Cereals production	732 (18.8%)	14,202 (31.8%)
Beef production	309 (7.9%)	2,703 (6.0%)
Mixed production	96 (2.5%)	1,710 (3.8%)
Outdoor production	70 (1.8%)	1,259 (2.8%)
Other grazing livestock	69 (1.8%)	753 (1.7%)
Other cattle husbandry	37 (1.0%)	331 (0.7%)
Pig husbandry	32 (0.8%)	496 (1.1%)
Greenhouse production	31 (0.8%)	657 (1.5%)
Poultry husbandry	3 (0.1%)	449 (1.0%)
TOTAL	**3,893 (100.0%)**	**44,689 (100.0%)**

In 2020, the food industry was the fourth largest industry in Northern Ostrobothnia after electronics, metal and forestry (SVT 2020). In the same year, the food industry had a total of 136 establishments, of which 125 were food manufacturers and 11 were beverage manufacturers (SVT 2020). The total number of employees in the food industry was 1,939 with a turnover of almost EUR 644 million. Including smaller-scale enterprises, there were 292 food manufacturers in Northern Ostrobothnia in 2020 (Aitojamakuja.fi 2020b). The sector is small and diverse, with as many as 83% of companies employing fewer than five people, and the

food industry in the region comprises several sectors. The majority (33%) of enterprises are in the bakery sector (Table 2)

Table 2. Food manufacturers by sector in Northern Ostrobothnia and the whole country in 2020 (Aitojamakuja.fi 2020b).

	Northern Ostrobothnia	Whole country
Bakeries	95 (33%)	949 (33%)
Slaughter and meat processing	52 (18%)	367 (13%)
Processing of vegetables, berries and fruit	41 (14%)	436 (15%)
Processing of other foodstuffs	39 (13%)	480 (16%)
Fish processing	32 (11%)	281 (10%)
Dairy processing	13 (4%)	107 (4%)
Milling industry	11 (4%)	111 (4%)
Production of beverages	9 (3%)	162 (5%)
TOTAL	**292 (100%)**	**2,893 (100%)**

During the past decade, several projects related to local food and the food sector have been executed in the province of Northern Ostrobothnia. For instance, RuokaGIS (Accessibility of local and organic food in Northern Ostrobothnia, executed in 2012–2014) project aimed to analyse local and organic food in a geographic context and to develop its availability and access to markets in Northern Ostrobothnia (Kotavaara et al. 2014). On the other hand, the possibilities of increasing the use of local food in institutional kitchens, in particular have been studied for instance in the Kekekupo project (Politiikkadialogi paikallisten hankintojen edistäjänä, executed in 2011–2013) (see Puoskari et al. 2013) and the RuokaNET project (Food chains regional network model to increase the use of local food in public kitchens, executed in 2014–2016) (see Korhonen & Muilu 2016).

In addition, the ELYKE project (Needs of Food Companies in Northern Ostrobothnia, executed in 2017–2018) aimed at finding out the actual situation of the food companies operating in the area as well as the directions and needs of operational development, to activate business activities and business cooperation in the field, and to promote the networking of companies and support service organisations. The project report (Korhonen et al. 2019c) presents a comprehensive overview regarding the food sector and its development needs in Northern Ostrobothnia.

The YLIKE project (Utilisation of surplus food as a part of circular economy, executed in 2017–2019) aimed to measure the amount of food waste among food

chain operators and food services in Northern Ostrobothnia (Korhonen et al. 2019a). The best measures for food services to reduce food waste were also compiled in a separate guide (Korhonen et al. 2019b).

In the last ten years or so, numerous other food chain development projects have also been implemented in the region. They have focused, among other things, on technological solutions (e.g. Labrobot [A72072]), traceability (e.g. Ruokajälki [A75911]), and natural products (e.g. Elintarvikkeista ja luonnosta elinvoimaa Koillismaalle [A70184]).

The project and development activities are expected to increase even more in the coming years, as the city of Oulu was selected as the European Capital of Culture in 2026 (https://oulu2026.eu/en/). The implementation area of the Oulu 2026 cultural capital programme includes 32 other municipalities in addition to Oulu. The Oulu 2026 programme encompasses an Arctic Food Lab programme and network focusing on local ingredients and traditional food. It has also launched a brand for the region (Oulu Culture Foundation 2022).

1.2. Objectives and scope

The aim of this dissertation is to examine regional organisation and management of activities that are perceived as sustainable and are related to food systems. I approach the theme of "sustainable food systems" by reviewing different sub-areas and their embodiments (local food logistics, consumer food-buying groups and food waste management) as well as their development among different food chain operators (producers, consumers, food service sector) on a relatively small regional level, in the province of Northern Ostrobothnia, Finland. The selected topics have been more prominent in recent years, in the contexts of both policy strategies and in public debate (see Chapter 1.1.). Additionally, I wanted to include topics throughout the system, from different stages of the food life cycle, and to consider perspectives from different actors operating in the system, to get a more comprehensive overview regarding this topic. By looking at multiple perspectives, it may also be possible to identify and highlight good practices from individual cases that can be adapted to serve a greater number of stakeholders. Also, using different data subjects can improve the reliability of a study (see Chapter 1.3.). The study area is limited to the regional level because it is based on projects carried out in Northern Ostrobothnia (see Chapter 1.3.), and the provincial level is a key level of regional development. Additionally, in general discussion, local food (which is dealt with in Articles 1 & 2) refers commonly to products which are produced in the same province where they are used.

According to a brief by the FAO (Nguyen 2018:1–2), a food system must be considered in the context of rapid population growth, urbanisation, growing wealth, changing consumption patterns, and globalisation as well as climate change and the depletion of natural resources. The rapid structural transformations over the past decades have resulted in increasing and significant challenges, with potentially wide-reaching consequences for the state of food security and nutrition. These include issues such as limited access of small-scale producers and agri-enterprises to viable markets; high levels of food loss and waste; and an increased energy-intensity and ecological footprint associated with the lengthening and industrialisation of food supply chains. In other words, questions of sustainable food systems can relate to, for instance, local production and new distribution infrastructures, the availability, accessibility, and affordability of nutritious food, as well as minimal negative impact to the environment (Story et al. 2009). Such comprehensive, multi-input research is scarce, and the themes above, as well as food chain operators, are often examined separate from each other.

This dissertation examines current issues/problems related to sustainable food systems in each of the stakeholder groups and presents possible solutions for them (or assesses whether they can be solved). However, my intention is not to evaluate the actual sustainability impacts of the sub-areas that I will discuss in this dissertation, but I do summarise in the Discussion (Chapter 4.1.) how the sub-studies in this dissertation seem to link to the definition of a sustainable food system (see Chapter 2.2.), and core dimensions of sustainability: economic, social, environmental (and cultural). The concrete objectives of my dissertation are formulated in three research questions presented below (they are further specified in the three articles). Positioning of the research question (articles) among the food system elements is pictured in Figure 2 (see also Chapter 2.2.).

1) What are the needs and possible solutions to improve local food logistics in Northern Ostrobothnia? (Article I)

2) What kind of alternative consumer-driven food supply chains exist in Northern Ostrobothnia and how have they evolved in the region? (Article II)

3) What measures have successfully reduced food waste among the food service sector in Northern Ostrobothnia? (Article III)

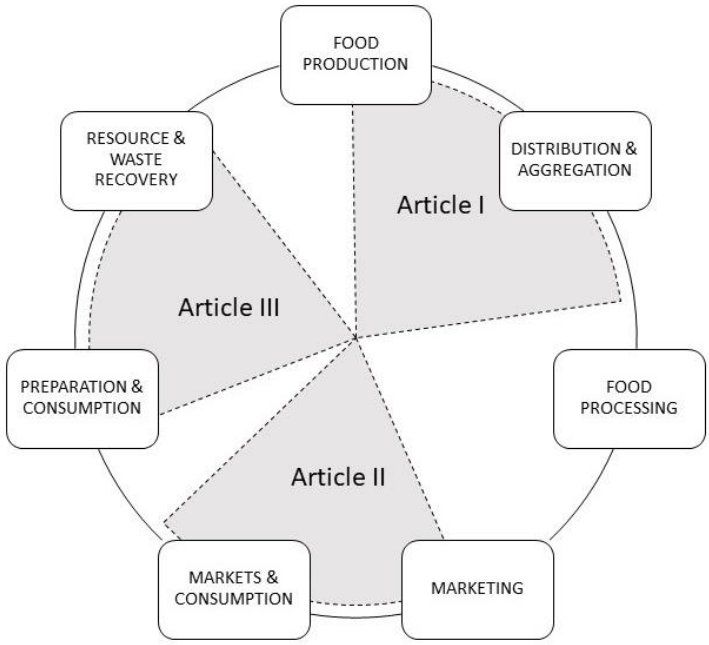

Figure 2. The main focus areas of the research questions (articles) vs. the food system elements (*the food system elements* are presented according to Davas-Fahey 2020). The dashed line indicates that the delimitation is not absolute.

Article I

The tendency of regional food supply chain distribution networks to be more fragmented and less efficient than the conventional food systems' centralised distribution networks has been identified as a challenging issue with local foods. This is furthered by a lack of mid-scale aggregation and distribution systems (see Day-Farnsworth et al. 2009). Additionally, there are several dimensions to consider regarding sustainable transport development; however, transport optimisation and intermodality has been identified as one of the key dimensions (Sztangret 2020). Traditionally, advocates of local food have paid attention especially to the reduced environmental impacts of transportation (Edward-Jones et al. 2008), but according to Mittal et al. (2018) one of the most common challenges of regional food supply chains logistics relates specifically to this.

The first article (Korhonen et al. 2017) tackles research question 1 (**RQ1**). It introduces an accessibility method for analysing the potential for integral networking of producers and transport companies. The study utilises qualitative analysis and quantitative geographic information system (GIS). There is a vast body of locational analyses for optimising facility sites' routes in the context of transport (see

Miller & Shaw 2001), but transport questions related to local food are rarely analysed. A Finnish case study (Piilo et al. 2007) surveyed the needs of small and medium-sized enterprises (SMEs) and developed different transportation solutions. However, there is clearly a lack of academic research considering local food accessibility in the context of cooperative networks of small producers. To increase competitiveness and market access of local food, new logistical solutions are needed, and transport accessibility plays a key role in this. Also, it is important to note that the sparse spatial structure of agricultural production and population set some challenges for the logistics of small-scale local food production.

The first article seeks to assess opportunities to establish centralised logistics services for small-scale berry producers using Northern Ostrobothnia as a case study. Information about favourable conditions for cooperative networks in the local food sector may help in establishing companies and stimulate their growth, and successful networking may increase scale economies in local production in transport, processing, and marketing. The piloted methodological framework will also be applicable to other fields of production and not only the mainly seasonal case study of berries. Berry production has a relatively strong role in the field of agriculture in Northern Ostrobothnia, but its logistics are notably underdeveloped. Additionally, the degree of processing around berry production is relatively low and its food safety regulations are lighter compared to livestock, for instance, so it is a highly suitable case for this study (see Kotavaara et al. 2014).

Article II

Local food is oftentimes associated with economic sustainability, and some studies (Seppänen et al. 2006; Viitaharju et al. 2014) have noted that locally produced food has positive impacts on the regional economy. Little et al. (2010: 1798) suggest that buying groups act as enablers in the distribution of local and organic foods, but they also may *'offer greater room for consumer voice and action, capable of animating ethical consumption practice'*. Also, according to Dedeurwaerdere et al. (2017), collective food-buying groups seek to bring about societal change by organising a protected space for learning and experimentation with lifestyle changes for sustainable food consumption and production practices.

The second article (Korhonen & Muilu 2022) tackles research question 2 (**RQ2**). It examines and evaluates the characteristics and stability of 'traditional' consumer buying groups – food circles (*ruokapiiri*) – in Northern Finland by studying their structure and changes in their status over a five-year period. Further, food circles are compared and contrasted to REKO rings, a new type of Facebook-based model for selling and distributing local food regionally (see page 2.2.3.).

While the establishment of food circles was particularly lively after rapid growth of the local-food trend around 2010, their operating environment has been experiencing changes in recent years. Also, the supply of local and organic food in grocery stores has improved.

Little et al. (2010) have studied food-buying groups and cooperative styles of purchasing in Europe, North America, and Japan. However, they noted scant reference to such groups in alternative food and ethical consumption literature. They observed that such studies would offer much, especially in terms of the historical context, future lessons for growth in the sector, and consumer motivation and ethics involved in buying groups. Also, in Finland there are not many studies examining food-buying groups. However, it seems that the interest in studying them has evolved just in recent years following the increasing popularity of REKO rings. Additionally, traditional food circles can be seen as having a kind of pioneering role in Finland, as they have been introducing the concept of collective buying, and making local and organic food more familiar to the consumer.

Despite the focus of this article on consumer-oriented food circles, which aim above all to meet consumer needs (availability of local and organic food, support for regional economies, avoidance of middlemen, etc.), distribution, sales and consumers, it should be noted that this study does not deal with (economic) profitability from the producer's point of view.

Article III

As mentioned in Chapter 1.1., the inefficiency of the food chain manifests as the vast amount of food loss and food waste. Seppälä et al. (2009) have estimated that of the climate-related emissions of Finnish consumption, food-related emissions are the second largest, immediately after housing-related emissions. Reducing food waste is one concrete way to influence the carbon footprint of the food chain. If food ends up as waste, the inputs used in its production, the environmental impacts and the costs of its production have been generated for nothing. Reducing food waste is a relatively simple measure that can improve food safety, generate economic savings and reduce the high environmental burden and emissions of food production (Dou et al. 2016).

According to the latest research (Riipi et al. 2021) the food service sector accounts for about 17% of all food waste in Finland. Silvennoinen et al. (2012) have noted that the potential to reduce food waste is considerable. However, previous food loss and food waste studies in Finland have mostly focused on the southern parts of Finland, and similar studies have not been conducted in a targeted

manner in Northern Finland. Studying this topic is also important especially because the public food services are guided to make more sustainable choices (e.g. purchase local and organic food). What role would these choices play if food ends up as waste? Also, Morgan (2008), for instance, has shown that public food services lead the way for consumers.

The third article (Korhonen et al. 2023) tackles research question 3 (**RQ3**). It adds information about the amount of food waste and the state of food waste management in Northern Finland and also brings up measures which have helped the operators in the food service sector (private and institutional restaurants) to reduce their food waste. The analysis relies on experiential as well as measurable data. In the third article and in this whole dissertation, the term food service sector refers to all outlets that prepare and serve food, including institutional food service outlets such as schools, day-care centres and workplace canteens. In Finland, the above-mentioned canteens form a significant part of the food chain, as they serve an estimated half of the meals consumed outside home (Silvennoinen et al. 2015). Most often these places serve buffet-style dishes that the customers serve themselves.

1.3. Research process and dissertation structure

My interest in studying and writing scientific articles about the subjects mentioned in the previous chapter emerged during my employment in two projects particularly: Lähi- ja luomuruoan saavutettavuus Pohjois-Pohjanmaalla – RuokaGIS (Accessibility of local and organic food in Northern Ostrobothnia) executed in 2012–2014 and Ylijäämäelintarvikkeiden hyödyntäminen osana kiertotaloutta – YLIKE (Utilisation of surplus food as a part of circular economy) executed in 2017–2019 (see also Chapter 1.1.1.). Moreover, I personally as a consumer have become increasingly interested in the origin of the food I eat as well as the food waste that I produce.

This dissertation consists of three articles and is based on the method of triangulation (e.g. Flick 2007). Taking different perspectives on the issue under study and using several methods should produce knowledge at different levels (Flick 2007). This means that they go beyond the knowledge made possible by one approach. Using more than one method can also improve the reliability of a study (Saaranen-Kauppinen & Puusniekka 2006). This study has used data triangulation and methodological triangulation. In data triangulation several different types of data are used in a single study, but also different data subjects can be used (Saaranen-Kauppinen & Puusniekka 2006). Methodological triangulation means that several methods of data collection are used to obtain research data

(Eskola & Suoranta 1998). Methodological triangulation provides a great opportunity to broaden and deepen the knowledge of the subject and it is particularly suited to research that collects information on human behaviour and its determinants (Saaranen-Kauppinen & Puusniekka 2006). The research methods and materials used in each article are summarised in Table 3.

Table 3. The research methods, materials and subjects.

	Article I (Korhonen et al. 2017)	Article II (Korhonen & Muilu 2022)	Article III (Korhonen et al. 2023)
Routing location models / accessibility analyses (GIS)	Primary production data (TIKE*) Digiroad (Finnish Transport Agency)	-	-
Surveys / Questionnaires	Agricultural producers (N=179) Food processing companies (N=51)	Food circle members (N=119)	Food service outlets (N=13)
Interviews	Food processing companies (N=6)	Frontmen / active members in food circles (N=7)	Food service outlets (N=8–11)
Food waste measurements	-	-	Food service outlets (N=8–11)

* Information Centre of the Ministry of Agriculture and Forestry.

Surveys and interviews were carried out in all sub-studies. According to Hirsjärvi et al. (2015), surveys or questionnaires can be used when gathering information about facts, behaviour and actions, knowledge, values, attitudes as well as beliefs, perceptions and opinions. The practice of using standardised questions in survey research is also based on the assumption that the responses will be given in a manner which allows the researcher to interpret and compare them (Järvinen 2012: 143). On the other hand, interviews can be used, for instance, when the research focuses on an unknown area and it is difficult for a researcher to know in advance the directions of answers, or when there is a willingness to clarify the answers available and when it is desirable to deepen the information available (Hirsjärvi et al. 2015). According to Eskola & Suoranta (1998) there is enough data when new cases no longer bring new information to the research problem, i.e., the material begins to repeat itself, so to speak.

The first sub-study used GIS, which is a system that creates, manages, analyses, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like

there). GIS helps users understand patterns, relationships, and geographic context (Esri 2023).

The data gathering for Article I (Korhonen et al. 2017) and Article II (Korhonen & Muilu 2022) were implemented in the RuokaGIS project. In Article II, literature was also used later on for a comparative analysis of traditional food circles and REKO rings (which did not yet exist in the research area during the project). The data gathering for Article III (Korhonen et al. 2023) was implemented in the YLIKE project. The research objectives of the projects as well as previous Finnish studies related to local and organic food (e.g. Isoniemi et al. 2006; Määttä 2012; Vänttinen & Korpi-Vartiainen 2010 and food waste (e.g. Silvennoinen et al. 2012; Silvennoinen et al. 2015, were taken into account in the design of the surveys and interviews.

At all stages, my dissertation follows ethical principles laid down in all relevant international, EU and national laws (EU General Data Protection Regulation). However, the data was collected before the execution of the EU's new data protection law (GDPR) so no consents to participate or consents for publication were gathered in written form. Responding to the surveys and interviews was voluntary. The results are presented without any personal information, and I do not mention any respondents by name.

Article I

The first paper (Korhonen et al. 2017) focuses on tackling the challenges related to the logistics of small-scale local food production. The study developed and applied transport accessibility methods (Miller & Shaw 2001) to explore opportunities for establishing 'local food' clusters integrating small producers into an effective and competitive network by the simplified routing location models approach (see Nagy & Salhi 2007). The study assessed numerical suitability of potential locations for logistic centres in sight of accessible producers. Accessibility analyses and data management were implemented by GIS. Spatial data of primary production volumes consisted of register records of farm-specific cultivation areas and average yields in Northern Ostrobothnia and Finland. Accessibility computations were carried out by using the digital model of the Finnish road network, Digiroad, which includes speed limits for travel time and route estimation.

The design and parameters for accessibility analyses were built upon the results of two questionnaires and six interviews implemented in 2013. Questionnaires were given to agricultural producers (179 responses with 18.7% response rate) and food processing companies (51 responses with 18.3% response rate) to seek

views on local food and its availability as well as food processing, sales, logistics and procurements. To survey the local food transport systems in detail, interviews focused on all clearly local food-oriented companies in the study region.

The study developed an approach considering locational advantages of a centralised logistics operator by applying a transport service-based collection routes model introduced by Bosona & Gebresenbet (2011). To inspect opportunities to locate a collection site optimally in relation to a potential collection network, spatial data consisting of primary production at the farm level was gathered from the Information Centre of the Ministry of Agriculture and Forestry. Farm-specific information included area under cultivation, which was transformed to a production estimate by average hectare yield data of each berry plant based on average hectare production at the country or county level. Data was connected to the accurate model of the road network including speed limits for travel time estimation and routing functions. Analysis in the study was executed by applying vehicle routing function to proxy an optimal collection route reaching production of farms optimally from potential collection centre locations.

Article II

The second article (Korhonen & Muilu 2022) processed the characteristics and stability of consumer food-buying groups (food circles) in Northern Finland, by studying their structure and changes in their status over a five-year period and reviewing their similarities and differences to REKO rings. An electronic survey was sent to the organisers or other contact persons of 15 different food circles in Northern Ostrobothnia in the spring of 2013. The survey link was distributed to the food circle members as was agreed with the contact persons. The survey included mostly multiple-choice and Likert scale questions that related to the definition, use, and availability of local and organic food as well as overall food circle activity. The survey data were derived using descriptive statistics, a non-parametric Kruskal-Wallis Test, and crosstabulations. The survey gathered 119 answers in total. The response rate could not be calculated because the survey link was distributed via food circle contact persons. However, we estimated, based on the number of food circle members according to the interviewees, that the survey responses cover about 13–19% of all households that participated in food circles in the study region during the time the data was collected.

In addition, seven semi-structured interviews were implemented during fall 2013 and spring 2014. Four of the food circles included in the interviews functioned or had functioned within the city of Oulu and three elsewhere in the Northern Ostrobothnia region. The interviewees were either leaders or otherwise active members in food circles. In the interviews, we asked about issues related to food

circle activity overall, the interviewees' thoughts about local and organic food as well as their own reasons for participating in food circle activity. For support, interviewees were also asked to fill in a preliminary information form asking for more information on the activities in the food circle. Two of the seven food circles had already closed down in 2012, before the interviews. The status of the other five food circles was investigated in the beginning of 2019 via email or phone. The interview data were transcribed word for word and analysed manually via thematising.

The analysis of REKO rings was based on the literature. The literature was searched via ScienceDirect and Google Scholar. There were not yet many international peer-reviewed papers regarding REKO rings, however, some theses had been done in recent years. The literature was examined using keywords regarding the same themes we dealt with for the traditional food circles.

The food circles for this study were sought mainly via Internet search engines at the beginning of 2013. In addition, a notice was posted on the webpage of a rural communication project. This study covered a notable portion of Northern Ostrobothnian food circles and their members, while we reached 10 of 12 of the most well-known food circles and five other food circles. However, it must be noted that smaller food circles focused on a specific neighbourhood, for instance, were rather hard to find; thus, their exact number in the region remained unknown. To preserve anonymity, the food circles involved in the study are not mentioned by name.

Article III

The third article (Korhonen et al. 2023) studied the amount of food waste and the state of food waste management in Northern Finland and, additionally, brought up measures which have helped professional kitchens (private and institutional) to reduce their food waste in the region. The analysis relied on experiential as well as measurable data.

The main material consisted of data from two food waste measurement periods. In addition, supplementary data was gathered via a survey, interviews and a workshop. The aim was to investigate the amount, quality and origin of food waste and prevailing measures in food waste management in the food service sector, as well as the interest in learning new management and utilisation methods to reduce food waste. The impact of different food waste reduction measures was also tested in practice, aiming at reducing food waste by 30%, which is the reduction target for 2025 in the EU (EUR-Lex 2014). Different food

service outlet types were included in the study to obtain a general overview of the situation.

Two food waste measurement periods were organised by following a method introduced by Silvennoinen et al. (2015). The focus was on food wasted during lunch (one week / 5 days in autumn 2017 and again in spring 2018). Between the measurement periods food waste campaigns were arranged for the restaurant personnel and customers. Participants were called from Northern Ostrobothnia by e-mail and through an electronic survey. A kick-off seminar was also arranged with the intention that those with interest had the opportunity to express their willingness to participate in the research. A total of 11 food service outlets participated in the first measurement period including five school canteens, four lunch canteens and two service station restaurants. Three of these participating locations were in Oulu and the rest within a radius of about 150 km from Oulu. Eight kitchens continued to participate in the testing of the food waste reduction measures as well as the second measurement period; five school canteens, two lunch canteens and one petrol station. In total, food waste data covering 101 days (or lunches) was gathered; half of these represented school canteens. The sample is not statistically representative but does give an overview of this unknown study area in the region.

Based on the results from the first food waste measurement period, the reduction measures / interventions were targeted at the areas with the highest losses. In simplified, the selected measures were compiled to combat kitchen waste, serving waste, and plate leftovers. The most appropriate measures were selected for each kitchen in cooperation with a staff representative.

In addition, an electronic survey was implemented in spring 2017 and again in autumn 2017 (due to low response rate). The survey's aim was to investigate the situation of food waste management in the food service sector in Northern Ostrobothnia, and to find operators who would be interested in testing different food waste reduction measures and participate in the food waste measurement periods. The survey link was sent to 249 operators which were known, including public and private operators in the region. Despite the re-run of the survey, it gained only 13 answers in total (response rate 5.2 %). However, some supporting information from restaurant personnel was also gathered via a workshop and free-form discussions (N=8) between the measurement periods.

Dissertation structure

After this introduction, the structure of this dissertation is as follows. First, I will go through the literature starting from "above" *sustainability* and *food systems*

and go deeper into sub-topics that are relevant in this dissertation, such as alternative *food networks*, *local food* and *local food systems*, *local food logistics*, *food-buying groups* and finally, *food waste* and *food waste management*. The last two list items focus specifically on the food service sector.

Secondly, I will present the results, starting from "upstream" of the food chain, including needs and possible solutions to improve local food logistics. Then I will move on to the markets and consumption, in this case alternative consumer-driven food supply chains, and finally, to the "downstream" of the food chain, i.e., food waste management, focusing on the food service sector.

Finally, I discuss the theoretical and practical implications of my dissertation as well as its reliability and validity. In addition, I give some recommendations for future research.

2. Literature review

2.1. Sustainability and sustainable development

According to Maryville University (2023), the concepts of sustainability and sustainable development are often used interchangeably. Sustainability is a broader term that describes the management of resources without depleting them for future generations. It goes beyond environmental sustainability concerning earth's natural resources, to include economic and social sustainability, which refers to meeting people's economic and social needs today without compromising the well-being of future generations. In comparison, sustainable development describes processes that improve long-term economic well-being and quality of life without compromising the ability of future generations to meet their own needs.

The concept of sustainable development became widely known following the publication of the Brundtland Report (Brundtland 1987) and thereafter was adopted into policy discours (Redclift 2005). According to Redclift (2005) the report was the first of its kind considering an overview of global environmental aspects of development from economic, social and political perspectives. In general, sustainable development includes three core dimensions of sustainability: economic, social and environmental. According to Sharma and Singh (2020) there are many ways to define, achieve and measure sustainable development. However, basically all are supported by the three fundamental dimensions and the evolving flow between them. The intersections of these dimensions could be, for example, socio-economic, biophysical or psychological. Basically, it can be concluded that nearly everything humankind does or plans to do on earth has implications for the environment, economy or society, and for that matter the continued existence and wellbeing of the human race (Mensah 2019).

According to Kahraman (2020) economic sustainability refers to practices that support long-term stability in economic growth without negatively affecting social, environmental, economic, and institutional aspects. The idea is that an efficient and responsible use of resources leads to long-term profitability (Maryville University 2023). Transitioning to a sustainable business can improve a company's chances of operating over the long term, for instance (Maryville University 2023).

Social sustainability, according to Ross (2013), *refers to equality, well-being, and balance across quality of life indicators between sociocultural groups over time and from one generation to the next*. In other words, social sustainability focuses

on the interrelationship of systems and processes that support the creation of healthy and liveable communities that can sustain themselves (Maryville University 2023). Social sustainability initiatives often cover issues such as the promotion of fair labour practices and wages; employee health, safety, well-being, and work-life balance; and diversity and equity (Maryville University 2023).

Environmental sustainability refers to actions such as reduction of carbon footprints, waste, and water usage while maximising energy efficiency (Maryville University 2023). These actions can provide both environmental and financial benefits, and show responsiveness to community opinion.

Some models of sustainable development are broader and include more dimensions. Sachs (1993) proposes a system with seven dimensions of sustainability: ecological, economic, spatial, cultural, political and psychological. Also, Pawlowski (2007) suggests that moral, technical, legal and political dimensions should be taken into consideration.

Cultural sustainability, for instance, is a dimension often linked to local food systems. Soini and Birkeland (2014) have investigated the scientific discourse on cultural sustainability by analysing the diverse meanings that are applied to the concept in scientific publications. Their analysis showed that the scientific discourse on cultural sustainability is organised around seven storylines: heritage, vitality, economic viability, diversity, locality, eco-cultural resilience, and eco-cultural civilisation. Some of the storylines establish the fourth pillar of sustainability, whereas others can be seen as instrumental, contributing to the achievement of social, economic, or ecological goals of sustainability.

The United Nations 17 Sustainable Development Goals (SDGs) are the targets for global development adopted in September 2015, set to be achieved by 2030 (see United Nations 2015). A sustainable food system lies at the heart of the SDGs, as they call for major transformations in agriculture and food systems in order to end hunger, achieve food security and improve nutrition by 2030 (Nguyen 2018). The SDGs are not legally binding, however, governments are expected to take ownership and establish national frameworks for the achievement of the 17 Goals. The Government report on the implementation of the 2030 Agenda not only describes the current state of Finland's implementation of the Agenda, but also the actions taken by the Government to promote the SDGs, the policy principles guiding their implementation at the national level and the organisation, monitoring and evaluation of the Agenda's implementation (Prime Minister's Office 2020). Sustainability of the energy system, sustainable use of forests, sustainability of Finland's aquatic ecosystems, sustainable food system and stronger equality and inclusion have been identified as key issues of sustainable development where ongoing efforts should be reinforced.

2.2. Food system(s) and sustainable food systems

According to IFPRI (2022): *'food systems are the sum of actors and interactions along the food value chain—from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal.'* They also include the enabling policy environments and cultural norms around food (see a simplified graphic of food system elements in Figure 3). On the other hand, the food system can be seen as composed of sub-systems such as farming systems, waste management systems, and input supply systems, which leads to the fact that a structural change in the food systems might originate from a change in another system, for example changes in the energy system (Nguyen 2018).

The OECD (1981) report on food policy presented the concept "food system" as broadly synonymous with the concepts of "food economy", "food chain" and "food sector". According to the report, these concepts refer to the set of activities and relationships that interact to determine what, how much, by what method and for whom food is produced. Additionally, the terms "supply chain" and "value chain" are oftentimes used in the context of food systems. The term supply chain tends to be more closely linked with logistics, whereas the term value chain focuses more on the product itself and the actors involved in determining what value is added and to whom benefits flow (Farmery et al. 2021). According to Mononen (2006) the definitions for food systems are usually abstractive while they do not make it clear who distributes the food, who interacts or who determines the method of food production, for instance.

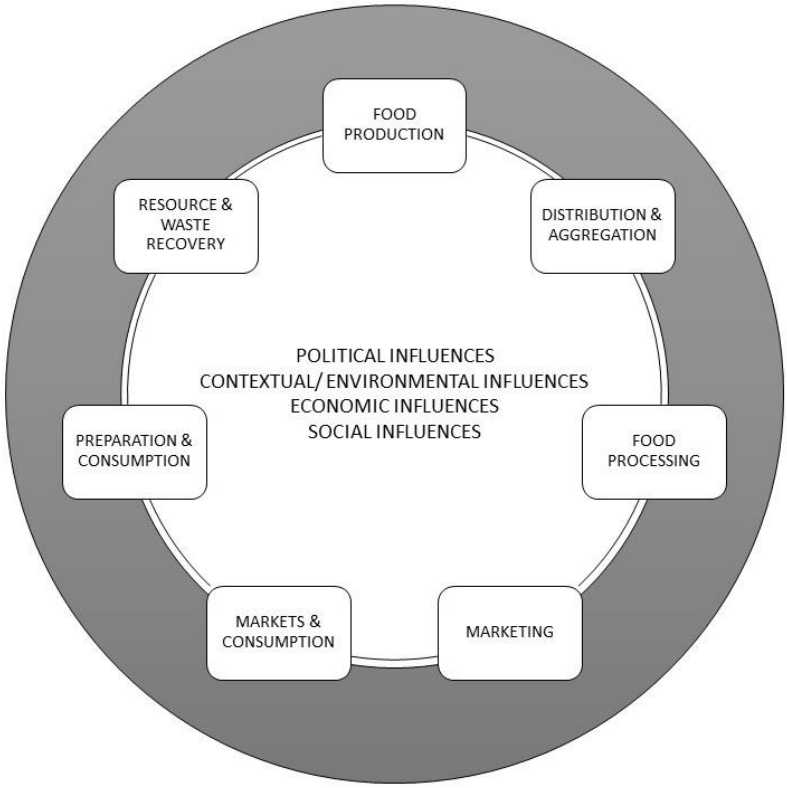

Figure 3. Food system elements (adapted from Davas-Fahey 2020; NCLFC 2022).

Stefanovic et al. (2020:1) state*: an indispensable component of the food systems approach are the food system outcomes that represent the results, or consequences, of the food system activities*. They discovered in their mini-review that the variety of discourses regarding the food system outcomes spans from food (and nutrition) security and global environmental change to resilience and food system sustainability, potential performance assessments and metrics and, finally, the food systems transformation (Stefanovic et al. 2020). In comparison, in a Finnish study, Puupponen et al. (2023) define the key desired food system outcomes as (1) food security and nutrition, (2) livelihoods and fair income, and (3) environmental sustainability and animal welfare. Further on, the core aspects of food security and nutrition are food availability, food access, food utilisations and stability of all of these (Bilali et al. 2018).

Most of the food system outcomes presented above can be found from the definition of a sustainable food system. A brief by the FAO (Nguyen 2018:1) defines a sustainable food system as *a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to*

generate food security and nutrition for future generations are not compromised. In more detail, the different dimensions of sustainability are described in the following sentences (Nguyen 2018). The economic dimension refers to the fact that the food system is profitable throughout, and the activities in the food system should generate benefits, or economic value-added elements, for all categories of stakeholders: wages for workers, taxes for governments, profits for enterprises, and food supply improvements for consumers. The social dimension entails that the food system has broad-based benefits for society, and its activities need to contribute to the advancement of important socio-cultural outcomes, such as nutrition and health, traditions, labour conditions, and animal welfare. Finally, the environmental dimension takes into account that the food system has a positive or neutral impact on the natural environment, and it considers biodiversity, water, soil, animal and plant health, the carbon footprint, the water footprint, food loss and waste as well as toxicity.

The definition of a sustainable food system can also be summarised as follows: *''provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come, with minimal negative impact to the environment; encourages local production and distribution infrastructures; makes nutritious food available, accessible, and affordable to all; is humane and just, protecting farmers and other workers, consumers, and communities''* (Story et al. 2009).

The challenges of sustainable development are linked, among other things, to the debate on the sustainability transition and the just transition. However, the research on the sustainability transition has paid relatively little attention to food and water (Markard et al. 2012) and the agri-food sector (Vermunt et al. 2020) for instance, even though the societal, political, and scholarly actors continue to push for the transformation of agri-food systems (Hebinck et al. 2021). Also, according to Tribaldos & Kortetmäki (2022) justice-relevant considerations regarding food system transitions remain scarce. However, Tribaldos and Kortetmäki (2022) have in their study identified principles for just low-carbon transition and criteria for just transition in food systems.

Discussion of the food system as a whole, as well as local and organic food, have generally increased on account of global food crises, especially during the last couple of decades (e.g. DuPuis & Goodman 2005; MMM 2009; PTT 2009; Harris 2010; Karttunen 2010; Tregear 2011). There have also been concerns that the traditional agro-industrial food system has not provided a nutritious, sustainable and equitable supply of food effectively enough (Donald et al. 2010). De-globalisation of food markets appears as a discourse within alternative food networks (e.g. Renting et al. 2003; Sonnino & Marsden 2006) as well as food system

localisation (e.g. Hinrichs 2003; Feagan 2007), although these two concepts are partly overlapped. The globalisation of the food system and the standardisation of food have been countered by active consumer and producer action as well (Mononen 2006). In fact, according to Mononen (2006) the increased demand for quality food has led researchers to talk about a kind of quality revolution. This can be characterised by the concepts of trust, localisation and rootedness, which refer to efforts to produce and supply food with transparency and based on the exploitation of the local ecosystem. According to Hendrickson and Heffernan (2002: 361): *'alternative food chain movements must organize where the dominant system is vulnerable*.' Next, I will go a little deeper into this concept.

2.3. Alternative food networks

According to Morgan et al. (2009), most alternative food networks (AFN) seem to have originated as a reaction to some negative trend in the conventional food system, such as the use of pesticides. Morgan et al. (2009: 188) states that: *'The vast majority of AFNs in Europe and North America seem to be committed to fashion food systems that are environmentally sustainable, economically viable, and/or socially just*.'

Traditionally, food supply chain is seen as a linear system describing the transport of a certain food, such as meat, grain or milk chains. In this type of supply chain, the interdependence between different actors is mainly sequentially organised, i.e., the output of one actor is the input of the next actor (Paananen & Forsman 2001). Also, the value created is mostly the result of minimising exchange costs and optimising logistics. In addition, the linear system ignores recycling, for instance (Mononen 2006), and the distance between the end user and primary production is often long both physically and in time (see Nygård & Storstad 1998). The latter results in the fact that knowledge of product origin at the end of the food chain can also become blurred, although even traditional supply chains nowadays aim for transparency throughout the chain.

Renting et al. (2003) have specified different types of alternative food networks. They specifically discuss short food supply chains (SFSC) such as organic farming, quality production and direct selling. In SFSCs, producer–consumer relations are "shortened" and defined by origin and quality-related attributes. The first category of SFSCs is particularly based on face-to-face interaction in such contexts as farm shops, farmers' markets and roadside sales. Whereas the second category of SFSCs is based on relations of proximity; this includes actions such as farm shop groups and community-supported agriculture, for example. However, Renting et al. (2003) emphasise that SFSCs are the results of active construction

of networks by different actors in the food chain, rather than the results of the external and elusive "free market". More recent studies have reviewed the logistics of the SFSCs (Paciarotti & Torregiani 2021) and the coexistence conceptual framework of SFSCs and food supply chains (FSC) (Thomé et al. 2020).

Paananen and Forsman (2001) have suggested that an alternative way of looking at the food supply chain is one where the number of actors in the chain is smaller than in the traditional model and the distance between actors is shorter, both physically and in terms of delivery time. This is the case, for example, in the local food systems, where the interdependence between actors is emphasised. This interdependence can usually be linked, above all, to the flow of information between the actors who are heavily dependent on each other's information. The local food systems also seek to minimise intermediate food storage and reduce the number of distribution channels at different stages of the supply chain.

According to Halweil (2002), the international success of direct marketing channels of food to consumers suggests that there is strong support for local food systems. Halweil (2002) states that the success is due to the high quality of products and the social interactions they provide, which puts direct marketing in a niche that anonymous grocery shops and multinational food corporations cannot fill.

2.3.1. Local food and local food systems

According to Enthoven & Van den Broeck (2021), there is no universal definition of local food systems (LFS), mainly because different interpretations of the 'local' scale exist. In the political sphere, LFS are defined differently across the world. In Finland, the concept of local food is usually used to refer to foodstuffs whose origin is geographically traceable (Mononen 2006). Also, the exact Finnish translation for local food would be *paikallinen ruoka* which differs little bit from the concept of *lähiruoka* (which in this dissertation would be the Finnish translation for local food).

In Finland, there are two commonly used definitions for local food. In 2000 the Finnish Working Group on Local Food (Maaseutupolitiikan yhteistyöryhmä 2000) defined locally produced food as *the production and consumption of food that uses raw materials and inputs of its own region of production, and promotes the economy and employment of the region*. The report also states that the local food production chain uses sustainable methods and favours seasonality. In addition, local food takes advantage of regional food traditions in product development and marketing. The Central Union of Agricultural Producers and Forest Owners

(MTK 2011) defines local food as *fresh, Finnish food produced as nearby as possible, with a known origin, producer, and manufacturer*.

According to Kotavaara et al. (2014), the definition of local food varies a little among different actors in the supply chain. There is no agreed distance limit for local food in Finland; however, in general discussion the distance limit varies usually from 50 to 100 kilometres. On the other hand, the discussions about local food in Finland commonly refer to products which are produced in the same province where they are used. As a comparison, in France food produced on a farm must be used within an 80-kilometer radius to be considered local (Blanquart et al. 2010).

Local food systems are associated with many benefits. Firstly, food produced close to its consumption environment is perceived to be both environmentally and economically sustainable (e.g. Kloppenburg 1996; Norberg-Hodge et al. 2002; Morgan 2008). Traditionally, advocates of local food have paid attention especially to the reduced environmental impacts of transportation (Edward-Jones et al. 2008); however, according to Yang and Campbell (2017) there are other potential benefits which food localisation may uniquely provide – including, for instance, recycling of energy, water, and nutrients.

Secondly, buying foodstuffs from producers nearby is considered to be a positive political action towards supporting agriculture and rural development policies. With the case of South Savo in Finland, Seppänen et al. (2006) have studied the potential effects of local food in the regional economy and created the RegAE (Regional Agro-Economic Model) input-output model. They have noticed that locally produced food has positive impacts on the regional economy, specifically that focusing foodstuff purchases on one's own region stimulates the regional economy's output while adding value and the demand for labour. Particularly, regions dependent on agriculture and food industry have opportunities to renew and promote business activities through local food. Also, Viitaharju et al. (2014) calculated that local food seems to have some economic potential for Finnish regions. Norberg-Hodge et al. (2002) also see local food systems as sustaining the local economy via maintaining jobs and promoting the circulation of money in the local area.

Thirdly, healthiness is also another positive feature often attached to local food. According to Isoniemi et al. (2006), local food is perceived to have much in common with organic food. Both relate to the idea of purity and production without artificial fertilisers and plant protection products. Beside this, the nutritional quality, especially of fruits and vegetables, may be affected by the various activities that occur along the supply chain (Edward-Jones et al. 2008). It could be expected that the nutritional quality of the products would be higher if consumers

collected them from a farm within a few hours of their harvest compared food harvested much further away.

According to Morgan (2008) attentive and demanding consumers are the most important factor in creating sustainable food chains. Public food services in particular have been seen as playing an important guiding role in promoting local food. Morgan (2008: 1237) states that: *'Creating a sustainable food service is the litmus test of a country's commitment to sustainable development because it involves nothing less than the health and well-being of young and vulnerable people*.' Also, the Finnish Working Group on Local Food (Maaseutupolitiikan yhteistyöryhmä 2000) has expressed its views on the fact that mass catering is the most natural way to use local food. However, promoting local food production requires that local food is clearly presented in shops and restaurants as well.

According to Kallio (2018), markets for local food barely existed in the late 2000s in Finland and it was extremely difficult to access either local or organic food. In 2011, the share of local food among consumer goods was estimated at 8% and that in the supply of special food stores, restaurants, cafes, and public institutions was estimated at 10% (Kurunmäki et al. 2012). In comparison, the share of local food in public institutions in 2020 was about 16% on average, varying between 1% to 47% in different provinces (Viitaharju & Kujala 2020). According to the MMM (2021a), due to statistical shortcomings, no precise figures on the evolution of the share of local food are available, but trade groups have reported an increase in purchases from local food entrepreneurs and an increase in the share of local food.

Local food systems have also come in for criticism and are sometimes referred to as 'the local trap', which refers to the tendency of food activists and researchers to assume that there are inherently positive qualities associated with localism (Morgan 2010). It is easy to think of food miles, for example, as a measure of a product's carbon footprint. In reality, however, the life cycle of the product is the only valid basis for this (Edward-Jones et al. 2008). Sustainability is also not necessarily synonymous with localisation when designing sustainable food systems. A sustainable food system, according to Morgan (2010), would be a combination of locally produced and globally sourced food. Also, Enthoven & Van den Broeck (2021) have discovered in their recent review study that the impact of local food systems on different social, economic and environmental factors highly depends on the type of supply chain under assessment, with important differences across product types and countries. In fact, their review refutes the idea that local food is inherently good.

One practical problem identified in using local food in the public sector is the difficulty for individual producers to participate in tenders (Morgan 2008). Also,

the final report of the Finnish Working Group on Local Food (Maaseutupolitiikan yhteistyöryhmä 2000) discusses the conflict between the promotion of local food and public administration legislation. Later on, efforts have been made to respond to this problem, and different guides have been published to facilitate the tendering process (e.g. Väänänen 2017).

2.3.2. Local food logistics

Logistics has been defined as '*that part of the supply chain process that plans, implements, and controls the efficient flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements*' (Mentzer et al. 2001). Logistics include production planning and the movement of food products from producers to consumers, including processing, storage, handling and packaging (Gebresenbet & Bosona 2012). Effective logistics management requires sufficient infrastructure to support consistent deliveries of the right product, in the right quantity, in the right condition, to the right place, at the right time, for the right cost (Aghazadeh 2004).

It has been identified that especially among regional food supply chains (RFSC) distribution tends to be fragmented and less efficient than the centralised distribution networks of conventional food systems (Gebresenbet & Bosona 2012), and there is a lack of mid-scale aggregation and distribution systems (see Day-Farnsworth et al. 2009). According to Mittal et al. (2018) the most common challenges of RFSC logistics relate to transportation (e.g. capacity shortages, empty backhauling, issues with security and contamination, concerns over environmental impacts and non-renewable energy consumption), warehousing (e.g. handling and storing a large number of stocks, storing units safely and efficiently, and lack of access to sophisticated physical warehousing infrastructures such as washing, cooling, packing and storage facilities), and inventory management (e.g. balancing demand and supply, seasonal fluctuations in regional food availability, and food traceability). On the other hand, some of the best practices for RFSC logistics regard transportation collaboration and facility location (Mittal et al. 2018). The transportation collaboration could be horizontal collaboration which occurs between organisations in different supply chains to better utilise assets and reduce overall costs, or vertical collaboration which occurs between entities belonging to the same supply chains. Facility location, on the other hand, affects labour costs, transportation costs, inventory holding costs and many indirect costs.

Also, in Finland in the case of small producers, lack of competitive logistics and small volumes limit the access of products to markets via centralised flows and

it is really important that local food producers develop networks with each other (see Piilo 2003; Järvelä et al. 2009). Especially among institutional kitchens the lack of logistics is one important reason why local food procurements are seen as quite inconvenient (Puoskari et al. 2013; Vänttinen & Korpi-Vartiainen 2010).

The National Local Food Programme (MMM 2013) states that there is an aim for advanced logistics for small batches, allowing profitable and sustainable business. The programme describes logistics challenges as follows (p. 10): *The logistics challenges are a good example of operations where cooperation between actors in the food chain is particularly important... It is important to create company-driven regionally networked wholesale arrangements and functioning profitable distribution chains that are also suited for very small batches… achieving large enough product volumes, secure deliveries and diverse ranges of products calls for new kinds of networked business operations and creating the conditions for the growth of, for example, entrepreneurship based on cooperatives. The opportunities offered by the current structures must also be taken into account in developing the logistics solutions.* The updated National Local Food Programme (MMM 2021a) continues to highlight logistics as an important area for development.

Traditionally, logistics cooperation is deeply organised around the typical primary production in Finland such as livestock and milk production, and logistics chains are highly functional towards wholesale and retail. However, in the case of local food, logistics is usually distributed via extremely small operators and mainly by the farmers. According to Latvala et al. (2017), agile and partly decentralised food production needs a functioning logistics system to support it. Raw materials and other ingredients needed in the food chain must be transported cheaply and reliably between producers, and final products are more often delivered fresh to the home, workplace or along the route, rather than to retail outlets. The current bottleneck in direct producer-to-producer or direct-to-consumer business is the lack of agile logistics. This is due to the funnel-like structure of the traditional food supply chain and the fact that logistics is based on a chain model. There are challenges in logistics for primary producers, as logistics systems suitable for small entrepreneurs do not yet exist, at least not on a large scale. This has been identified as a crucial factor for the success of small and medium-sized enterprises. Food SMEs and rural businesses mostly have to transport their products to the market themselves, which is generally not cost-effective, especially over long distances.

Logistics has been identified as one of the development areas in the surveys of several projects in Northern Ostrobothnia (Määttä 2012; Kotavaara et al. 2014; Simunaniemi 2015). Long distances, in particular, were seen as a challenge, as the major players in the food industry are very much concentrated in Southern

Finland. However, with advanced technology, long-distance transport could be organised by maintaining cold or hot chains (Vuorela 2017). Another relevant challenge in local food production is storage. Both the producers' own facilities and those of the professional kitchens that use them, for example, are often small or non-existent (Kotavaara et al. 2014).

Paciarotti & Torregiani (2021) have recently conducted a review study regarding the logistics of the SFSCs. The main research themes were dealing with the elements of logistics affecting the environmental impacts of SFSC, location and route optimisation, improvement of SFSC logistics through supply chain restructuring and other logistics-related issues. Bosona and Gebresenbet (2011) investigated local food supply networks in sight of large-scale food distribution centres and identified computationally suitable gravity centre locations for local food clusters in Sweden. Moreover, to integrate local food producers within networks of suppliers, distributors, customers and community representatives in order to increase their competitiveness, Bosona et al. (2013) evaluated the performance of an integrated food distribution network in Sweden, by GIS-based location and route analyses including producer, customer and distribution centre data. Again, producer-specific data has been applied recently for developing gastro tourism in the case of beer routes optimised to visit small-scale breweries and beer houses in Hungary (Csapó & Wetzl 2016).

2.3.3. Food-buying groups

One example of AFNs are different kinds of food cooperatives such as food-buying groups, although they are not a new phenomenon according to Belasco (2007). The food cooperatives in America were frequently constructed as a means of creating change through the everyday acts of food purchasing and distribution, particularly in the 1960s and early 1970s (Belasco 2007). The interest in them has been greatest during times of recession, as one of the goals of food circle activity has been a lower price level for food (Herrmann 1993). However, the motivations behind individual members' decisions to join the cooperative movement were multi-varied (Cox 1994). Little et al. (2010) suggest that buying groups can be viewed as a microcosm of the 'diverse economy', outlined by Graham et al. (2002) and Gibson-Graham (2005), which encompasses both corporate and not-for-profit, waged labour, and payment-in-kind as well as personal and communitarian gain.

Little et al. (2010) have studied food-buying groups and cooperative styles of purchasing in Europe, North America, and Japan. They (Little et al. 2010: 1798) suggest that: *'collective purchasing groups may represent an important form of agri-food network and, crucially, may also offer greater room for consumer voice*

and action, capable of animating ethical consumption practice'. Buying groups act as enablers in the distribution of local and organic foods, and social and communitarian capital is also derived and generated through the process of collective action. Also, according to Dedeurwaerdere et al. (2017), collective food-buying groups seek to bring about societal change by organising a protected space for learning and experimentation with lifestyle changes for sustainable food consumption and production practices.

Some challenges identified associated with food buying groups are related particularly to the number of their members. According to Ronco (1974), as the number of members grows, food buying groups face dilemmas between continuing growth and maintaining their founding principles. Kump and Fikar (2021) have recently evaluated the challenges of maintaining and diffusing grassroots innovations in alternative food networks by using a systems thinking approach. They came to a similar conclusion as Ronco (1974): food cooperatives seem to have an 'optimal size', and when such systems become too large, there are negative feedback loops affecting motivational aspects of the users. They also noticed that the diffusion of alternative food networks into the mainstream may be achieved through replication and translation strategies, rather than scaling-up.

Some examples of successful food co-ops and food-buying groups in Europe are Voedselteams (Food Teams, started in 1996) in Belgium (see Zwart & Mathijs 2020), 'Gruppi di acquisto solidale' (Solidarity Purchase Groups or GAS, started in 1994) in Italy (e.g. Maestripieri 2016), the French community supported agriculture movement 'Associations pour le Maintien de l'Agriculture Paysanne' (AMAP, first groups founded in 2001) (e.g. Lagane 2015), and the community supported agriculture movement in United Kingdom (begun in 2013) (CSAUK 2022). One example of food circle action in the USA is The Kansas City Food Circle organisation (KCFC) officially started in November 1994 (see e.g., Hendrickson and Heffernan 2002).

Food collectives in Finland remained fairly unknown until taking off in the 2010s, establishing themselves as one way to access and purchase locally farmed food on a regular basis (Kallio 2018). The development of food circles in Finland as sales venues for local food has also stirred conversation about the communal nature of food acquisition (Kurunmäki et al. 2012). Food circles can be perceived as part of a communal economy, in which production and consumption take place voluntarily among people of a certain community and are based on a genuine will to participate in development and sharing (Forss and Kanninen 2013). The economy is thus a way to achieve social and ecological goals, and food circles are associated with consumer-citizenship.

A simple definition for a traditional food-buying group, aka food circle (*ruoka-piiri*), is provided in a guide published in 1999 by the associations Maan ystävät ry – Friends of the Earth Finland and Biodynaaminen yhdistys ry – the Finnish Biodynamic Association (Airaksinen et al. 1999): '*A food circle is a group of people who buy their food together*'. Products can be purchased directly from farmers or ordered from special eco-shops or wholesale businesses (as in the case of imported products). Voluntary labour and togetherness are an integral part of the circle. They can be registered or informal, but they are based on non-profit pursuits with as few intermediaries as possible. Food circles can be found all around Finland, however, with the densest concentration in the south of the country, specifically in the capital region (Kallio 2018). They may differ greatly on the basis of their size and location, as well as in terms of how they organise food procurement in practice. According to Kallio (2018): *'Each food collective adapts to its surroundings and local conditions and ends up representing the needs and wants of its participants'*. Food circles that have been longer in action are often centred on organic products, with additional emphases on locally grown food (Lamberg 2009). In 2016, there were over 100 food circles around Finland (Pro Ruokapiirit ry 2016).

In addition, a new type of Facebook-based model for selling and distributing local food regionally is known as *REKO*, which stands for *REjäl KOnsumtion (fair consumption)* (see e.g. Yrkesakademin I Österbotten 2016; Szymoniuk and Valtari 2018; Kumar et al. 2021). REKO rings operate in closed Facebook groups, where a producer writes a Facebook post about his or her product and supply, and consumers order the goods by commenting directly below the post (Snellman 2021). According to 'REKO – Fair consumption since 2013' (Snellman 2021), a recently published "e-book" presenting the concept of REKO and how it has developed in less than a decade, there were 210 REKO rings with 4,000 producers, 435,000 members and 35 million euros in revenue in Finland in 2021. The first REKO rings were established in Finland in 2013 and the concept has also spread abroad, particularly to Sweden (see Gruvaeus & Dahlin 2021) and Norway. In total, there are over 600 REKO rings with more than 2 million members in 14 different countries.

2.4. Food waste and food waste management

A report by the FAO (Gustavsson et al. 2011) estimated in 2011 that around one-third of food produced globally was lost or wasted. However, it is acknowledged that there is a lack of household food waste data outside of Europe and North America (Gustavsson et al. 2013). In addition, differences in definitions of food loss and waste and diverse quantification methods used have added to data

ambiguity (see Xue et al. 2017). According to the FAO (2013), the term food loss refers to a decrease in mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption, and the term food waste refers to food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil.

The Food Waste Index (UNEP 2021) estimated that around 931 million tonnes of food waste were generated worldwide in households, retail establishments and the food service industries in 2019. Food Waste Index defines food waste as 'food and the associated inedible parts removed from the human food supply chain.' In the EU, it has been estimated that around 88 million tonnes of food waste are generated annually with associated costs estimated at 143 billion euros (European Commission 2022). This estimation also includes inedible parts, such as bones, rinds and pits/stones but covers the sectors of primary production and processing as well.

In Finland, the amounts of food waste have been investigated throughout the food chain and targeted identified problem areas, such as food waste in households (Koivupuro et al. 2010; Silvennoinen et al. 2012; Hartikainen et al. 2013; Hartikainen et al. 2014) and food waste in the food service sector (Silvennoinen et al. 2015; Silvennoinen et al. 2019). According to the latest research (Riipi et al. 2021) the amount of food waste in Finland is about 643 million kilos per year when inedible parts are included, and 351–376 million kilos a year including only edible food. It is estimated that about a third (33%) of the latter is generated in households, 23% in the food processing industry, 17 % in the food service sector, 16% in retail, and 11 % in primary production (excluding crops remaining in the field).

According to Riipi et al. (2021) the most of food waste in the food service sector originates from serving and only a small fraction from leftovers. A previous study (see Silvennoinen et al. 2012 & Katajajuuri et al. 2014) discovered that the amount of food waste ranges from 7% to 28% for cooked food, depending on the restaurant type. The amount of food waste in the most relevant restaurant types regarding this dissertation are presented in Table 4.

Table 4. Share of food waste for cooked food among different restaurant types in Finland (adapted from Korhonen et al. 2023; data from: Silvennoinen et al. 2012 & Katajajuuri et al. 2014).

	Kitchen waste	Serving waste	Leftovers	Food waste in total
Workplace restaurants and canteens	3%	17%	4%	24%
School canteens	2%	11%	5%	18%
Cafes and service station restaurants	5%	10%	4%	19%

During recent years numerous studies regarding food waste prevention have been conducted. For instance, Reynolds et al. (2019) evaluated the effectiveness of different interventions by reviewing 17 food waste prevention intervention studies at the consumption/consumer stage of the supply chain. They identified that interventions that changed the size or type of plates were shown to be effective (up to 57% food waste reduction) in hospitality environments. In addition, information campaigns were shown to be effective with up to 28% food waste reduction in a small sample size intervention.

Bilska et al. (2020) have developed a risk management model of food waste based on the ISO 31000 standard for food service establishments, to learn the causes of food waste, and, on this basis, to estimate the risk of food waste in foodservice establishments. They identified a medium risk level for fruits and vegetables, and bread, and high risk level (not acceptable) for semi-finished products, hot and cold served dishes, expired products, products with signs of spoilage, and products with no visible signs of spoilage. In Finland, Riipi et al. (2021) identified that a majority (20%) of service waste consist of main courses including meat, side dishes being the second largest (15%) group, followed by salads (14%). Heikkilä et al. (2016) studied reasons and sources of food waste in restaurants in Finland. They identified eight factors affecting food waste: society/society's culture, business concept, product development and procurement, the restaurant's management system, professional skills, diners, competitors, and communication.

Some studies have compiled lists of concrete measures to reduce food waste (see e.g. Betz et al. 2015; Sakaguchi et al. 2018). Bilska et al. (2020) have suggested two risk treatment options: prevention and tolerance, meaning that the risks must be prevented by eliminating any errors that may result in food waste, however to some extent, the risks must be tolerated, and products that are

unsuitable for human consumption should be disposed of. Hennchen (2019), on the other hand, has applied practice theory to study the issues of food waste in the food service sector in southern Germany. He concluded that future studies should focus on how to integrate innovations into different work routines instead of educating professionals by providing guideline knowledge.

In addition, Filimonau et al. (2019) have discovered that food waste management frameworks, such as the EU Waste Legislation (European Commission 2022), does not necessarily reinforce prevention measures applied by specific (agricultural, food manufacturing, grocery retail and/or food service) businesses on the ground (FUSIONS 2016). These offer EU restaurateurs a scope of flexibility when selecting approaches to food waste management, and as a consequence the restaurants tend to take advantage of those management approaches that are less laborious and most cost-effective from the business operational viewpoint. Filimonau et al. (2019) highlighted that the implementation of effective food waste management practices such as surplus food redistribution, offer of food-to-go boxes, portion control and on-site food waste separation and recycling require genuine corporate commitment to mitigate food waste.

Several studies have been conducted regarding the reuse of surplus food. Hecht & Neff (2019) have evaluated nineteen different studies regarding food rescue interventions. They noticed that many studies suggested promising effects of food rescue interventions, including positive return on investment, decreased environmental burden, large quantities of food rescued and served, and high stakeholder satisfaction. During the past decade, some efforts have been made to utilise the surplus food in different ways in Finland as well. For example, the municipality of Tyrnävä in Northern Ostrobothnia made a decision to allow schools to sell their surplus food (Rättilä 2015). Some restaurants have also shown their interest in taking advantage of the food waste from retailers and, correspondingly, the surplus foods of the restaurants have been sold or passed on (e.g. Kaitasuo 2016). In addition, various "food rescue" apps help consumers to find and buy food leftovers from restaurants.

3. Results

3.1. Needs and possible solutions to improve local food logistics in Northern Ostrobothnia (RQ1)

Article I (Korhonen et al. 2017) applied geographic information system (GIS)-based accessibility analyses for analysing the potential for integral networking of local food production and transport companies. Berry production was selected as a case study because it has a relatively strong role in Northern Ostrobothnia, its logistics are notably underdeveloped, and its food safety regulations are lighter compared to livestock, for instance. We used spatial data of primary production volumes which consisted of register records from 2012 of farm-specific cultivation areas and average yields in Northern Ostrobothnia and all of Finland. Accessibility computations were based on the digital model of the Finnish road network, Digiroad. In addition, two surveys were implemented to gather data from farmers (N=179) and food processing companies (N=51).

Our surveys revealed the need for a local food wholesaler or other logistical feature integrating local products because the access of products to grocery markets is limited due to low volumes, supply reliability is not strong, and branding is often at a weak level. In addition, the trade in alternative food chains such as farmers markets and food circles usually rely on specialised consumers and their lower accessibility in rural areas limits growth opportunities. On the other hand, food processing companies have realised the market value of local products and are interested in using them more.

Both agricultural producers and food processing companies saw that on a general level, requirements on price level, requirements related to the amounts of supply, lack of knowledge about potential customers and their needs and problems related to logistics have a negative effect on delivering products to local actors. Food processing companies also identified needs for development in enhanced supply, co-operation of farmers, processors and consumers, a local food wholesale or other logistics integrating products, local food outlets and joint transportation for products. In fact, our surveys revealed that only about 10% of agricultural producers cooperated in transportation.

About a third of all agricultural producers transported products on their own. The most active ones were outdoor horticultural producers. Transportation was most frequent during the growing season and at most it occurred daily or even several times a day, usually by vans. The key figures for the most active producers doing transportation are shown in Table 5.

Table 5. The key figures for producers doing transportation. Deviating extreme values have been excluded. The most active producers were selected by looking at direct sales, production volumes and routes, and transport frequencies.

Most common means of transport	Average transport distance (N=51)	The average maximum transport distance (N=44)	The average minimum transport duration time (vans or equivalent vehicles, N=20)	The average transport duration time (all, N=51)
Van (N=31)	50.7 km	100.5 km	2.98 h	3.2 h

Accessibility indices for a local food collection centre showed that berry production could be collected efficiently from a relatively large area using relatively modest limited resources. Based on the analysis, it would be possible to build the collection logistics so that only five three-hour routes would reach 63.7% of the berries, with a total production of 652.1 tonnes in the region (see Table 6). The most suitable sites were found in southern parts of the region between and within Ylivieska and Siikalatva.

Table 6. Accessibility of berries from potential collection sites by five three-hour-long routes (adapted from Korhonen et al. 2017).

			Accessible berry production (t)		
Type of berry	Farms (N)	Production sum (t)	From most accessible node	Average of all nodes	From least accessible node
All berries	212	652.1	415.5	257.2	3.1.

When accessibility of berries (sea buckthorn, raspberry, black currant and strawberry) was analysed separately, the most efficient opportunities for accessing production were generally found in the southern parts of the study area. Strawberry had the most eastern emphasis in Siikalatva, whereas the best sites to collect sea buckthorn had mostly a northern emphasis. The most efficient black currant collection sites were more spread out and located in southern areas, whereas the best raspberry collection sites were found in the middle in relation to the other areas.

Different routing settings were used to evaluate the efficiency of accessing different berry production sites (see Table 7). The actual average duration of farmers' own delivery routes was three hours. In addition, six- and nine-hour routes were included in the analysis for proxying full-time logistics operator capacity.

The key finding was that the location of a collection site could be anywhere within the southern half of the study area, but the most efficient locations were within Siikalatva and Siikajoki. We discovered that five six-hour routes could cover almost all berry production in the area, whereas only one nine-hour route could be used to cover 62.6% of berry production, which is almost as much as with five three-hour routes. However, due to fine preservation requirements in the case of berry production it might be more beneficial to operate with five shorter routes and deliver products to consumers, for preservation or further processing during the same day.

Table 7. Effect of transport time-distance and fleet size on accessibility of berry production (total 652.1 t) from potential collection sites (adapted from Korhonen et al. 2017).

	Travel time max.	Collected max value (t)
1 route	3	218.2
	6	353.1
	9	408.1
5 routes	3	415.5
	6	627.8
	9	646.7

3.2. Existence and evolution of alternative consumer-driven food supply chains in Northern Ostrobothnia (RQ2)

Article II (Korhonen & Muilu 2022) examined and evaluated the characteristics and stability of food circles (ruokapiiri), traditional food-buying groups in Northern Finland, by studying their structure and changes in their status over a five-year period (2013–2019) and reviewed their similarities and differences to REKO rings based on field-specific literature. The study reached a notable portion (10/12) of the most well-known Northern Ostrobothnian food circles and their members via an electronic survey (N=119) and interviews (N=7). The study was carried out at a time when development in local and organic food sectors was extremely rapid and the popularity of social media-based REKO rings had exploded.

Food circles were usually seen as a functional way to purchase local and organic foodstuffs and they offered an opportunity to make ecological choices. However,

only two of the seven food circles interviewed were still operating in 2019. The oldest and still active food circle in this study had been in the trade register since 1990. Six of them were established by one or more (environmentally) active consumers and only one began in the context of a local food-related project. The food circles involved in our study had several reasons behind their formation: there was an intention to make local and/or organic food better available as well as willingness to promote local and organic food activities overall, to 'avoid middlemen' in the supply chain, to offer an opportunity to make environmentally friendly food purchases, and to help people consider their consumption choices, respecting nature, encouraging ecological thinking, and so on. Some of the interviewees reported that they had wishes related to reducing food transportation mileage and logistics emissions by shortening the food chain. In comparison, the operation of REKO rings is generally speaking considered as very ethical and ecological.

The estimated number of households participating in each food circle varied between 10 to 120. Although it seemed that people with different backgrounds (e.g. age, education, employment, and family situation) had interest in food circles, most commonly 'the average members' were educated, working urban women as is also identified in other studies related to food co-ops (e.g. Szabó 2017; Schifani and Migliore 2011). REKO rings, on the other hand, seemed to have more variety among their member base in general.

About half of the survey respondents also favoured traditional and easy-access acquisition channels such as supermarkets and corner shops to purchase local and organic products, whereas others preferred face-to-face encounters with producers. The different needs and preferences of food circle members probably also resulted in the fact that the average monetary amount of orders was also rather low (app. 50€) even though orders were placed relatively rarely, usually once a month.

Some of the food circles preferred organic food and some local food. In case of organic food, it sometimes meant that some of the products came from further afield (even abroad) and the production method, particularly in organic food circles, was a more important criterion than nearby production. In addition, not all interviewees (or food circle members) considered the ecology of food circles to be obvious; they pondered the rationality of food-circle logistics as the members lived in a quite scattered fashion and the number of ordered goods per person might have been rather small. However, some food circles and REKO rings actually also encouraged local distribution infrastructures to some degree. According to the survey, some of the food circle members carried out joint transportation with other members while picking up the deliveries. On the other hand, in the

case of REKO rings it has been noticed (Snellman 2021: 69) that one unexpected outcome of the REKO concept is *that the producers now have colleagues they meet regularly at various REKO drop-offs in the region. This has also created a distribution network with producers who buy from each other and help each other to deliver products.*

One of the challenges identified was that there was a set of more occasionally participating 'supporter' members involved in food circles. The increased driving brought up by a few interviewees also contradicted their founding principles regarding sustainability. The likely reasons behind these negative comments were poor management and their unclear legal status, while a majority of food circles were lacking official rules and subscription fees or the equivalent. In contrast, food circles typically operate on a rather 'closed' basis, so it might be expected that in such cases their life cycles come to an end at some point, while the members of the group grow out of the demand for such action for one reason or another. Also, food circles from this study had a relatively low turnover among their member base.

According to our findings it seems that traditional food circles and modern REKO rings do not have many differences on a practical level (see Table 8). However, the REKO rings are better known on a mainstream level and buying through them is easy if one has a profile in Facebook. Pick-ups for REKO rings are organised more frequently and the product range seems to be wider on average. For instance, they offer certain products more often, such as meat and fish, whereas food circles focus more on products that are easy to deliver from the cold chain perspective. While REKO rings usually operate geographically in larger areas, such as cities (vs. food circles that operate typically in a specific neighbourhood or community), it seems that the involvement of its members is not as important, as there are enough subscribers in any case. Nonetheless, REKO rings also face some challenges, especially regarding the workload of producers, and their dependency on the Facebook platform, as its continuity is questioned. However, they do not depend on volunteers, which is at the heart of the activity of traditional food circles.

Table 8. Basic features of food circles and REKO rings.

	Food circles	REKO rings
Began operating in the region	at least since 1990	since 2015
Arranging of orders	email / online order form	Facebook group
The typical frequency of pick-ups	once a month	biweekly
The typical operation area	neighbourhood	city or municipality
Typical challenges	'supporter' members dependency on volunteers	workload of producers dependency of the Facebook platform

The REKO rings seem to have largely replaced traditional food circles in the study region, and in fact, many discontinued food circles reported that their members had switched to REKO rings. In addition, the one operating in the city of Oulu is reported to be one of the most active REKO rings in Finland. The demand for these kinds of groups probably still indicates the low availability of local and organic food in the region, but also the fact that a set of consumers value social aspects and face-to-face interaction without middlemen.

3.3. Successful measures to reduce food waste among food service sector (RQ3)

Article III (Korhonen et al. 2023) studied the amount of food waste, the state of food waste management, and measures which have helped the operators in the food service sector (private and institutional restaurants) to reduce their food waste in Northern Ostrobothnia. The main material consists of data from two food waste measurement periods covering 101 days (or lunches) in total. In addition, supplementary data was gathered via a survey (N=13), interviews (N=8), and a workshop.

According to the survey responses, operators in the food service sector considered that the utilisation of surplus food is important. A majority of respondents (N=10) reported that they sometimes had been monitoring the amount of food waste, for example, by following the emptying of the bio-waste bin, the amount of plate leftovers, and the loss in euros. The respondents estimated that the share of food waste originating from storage was low, while the inventories are closely monitored and orders are cancelled if the goods seem to accumulate, for instance. Additionally, products with expiring dates were utilised through menu changes. The serving waste was sometimes handled by selling dishes at a lower

price at the end of the lunch hour, and there were also efforts to reduce the amount of plate leftovers through guiding/education, particularly among schools. Five respondents estimated that 50–95% of leftovers end up in composting, and two respondents reported that all food waste goes to waste incineration.

The first measurement period (baseline measurements) showed approximately 7–35% food waste in comparison to prepared food (Table 9). This fluctuated on both sides of the national averages of 18–24% for these types of restaurants (see Silvennoinen et al. 2012 & Katajajuuri et al. 2014). A major part of the food waste in each food service outlet originated in buffet serving, varying between 5–27%, whereas the amount of kitchen waste varied between 0–11%, and the amount of leftovers 1–8%.

Table 9. Share of food waste for cooked food (adapted from Korhonen et al. 2023). MP=measurement period.

	Total food waste		Kitchen waste		Serving waste		Leftovers	
	MP 1	MP 2	MP 1	MP 2	MP 1	MP 2	MP 1	MP 2
School 1	14.9%	15.4%	0.3%	0.0%	9.3%	9.1%	5.3%	6.3%
School 2	10.5%	5.9%	0.3%	0.0%	5.6%	2.1%	4.6%	3.8%
School 3	23.7%	14.0%	4.0%	0.0%	13.3%	7.7%	6.3%	6.3%
School 4	21.4%	24.9%	5.1%	6.4%	10.2%	14.9%	6.1%	3.6%
School 5	14.3%	8.0%	0.5%	0.3%	9.1%	4.3%	4.7%	3.5%
Canteen 1	7.0%	-	1.1%	-	5.1%	-	0.8%	-
Canteen 2	18.4%	-	0.0%	-	15.4%	-	2.9%	-
Canteen 3	14.3%	18.3%	3.8%	4.1%	8.0%	7.8%	2.5%	6.3%
Canteen 4	30.8%	22.1%*	10.8%	-	12.5%	16.2%	7.4%	5.9%
Service station 1	34.6%	-	0.0%	-	26.9%	-	7.7%	-
Service station 2	24.0%	24.1%	2.2%	2.3%	14.8%	16.5%	7.0%	5.3%

* The result is unreliable because kitchen waste was mixed with biowaste during the second measurement period.

Based on the results from the first food waste measurement period, the reduction measures / interventions were targeted at the areas with the highest losses: kitchen waste, serving waste, and/or plate leftovers. The most appropriate measures were selected for each kitchen together with a staff representative. Our goal was to reduce food waste by 30% and this was successfully reached in three school canteens (2, 3, 5, see Table 10). Lunch canteen 4 also reduced its food waste, but the goal was not quite reached. Their total amount of combined

biowaste + kitchen waste during the first measurement period was 153 kg, and this was measured as biowaste only during the second measurement period, with a result of 51 kg. However, this indicates that kitchen waste was also potentially reduced. In school canteens 1 and 4, the amount of food waste increased. In the case of school canteen 1, the amount of food waste was already relatively low and below the national average. In school canteen 4, the increase was seen as a consequence of their changed management strategy after the baseline measurement – the new strategy was to utilise a centralised kitchen instead of a local preparation kitchen. In service station 2, the amount of food waste also increased, probably partly due to an increased amount of food prepared per diner. Finally, in lunch canteen 3, the overall food waste remained the same.

Table 10. Change in amounts of prepared food and food waste (between measurements 1 and 2) and reduction measures (adapted from Korhonen et al. 2023).

	Prepared food	Total food waste	Kitchen waste	Serving waste	Leftovers
School 1	8.9%	12.2%	-100.0%(1	6.4%(3	29.2%(5,7
School 2	11.1%	-36.9%	-100.0%(1	-57.2%(3	-7.4%(5,7
School 3	-16.8%	-50.9%	-100.0%(1,2	-51.9%(3	-18.0%(5,6,7
School 4	8.3%	26.2%	35.9%(1	58.0%(3,4	-35.5%(5,6,7
School 5	1.2%	-42.9%	-48.7%(1	-52.2%(3,4	-24.3%(5,6,7
Canteen 3	-20.0%	2.4%	-12.6%(2	-21.9%(3,4	104.5%
Canteen 4	-4.7%	-31.7%*	-100.0%*(2	23.5%(3	-24.9%(5
Service station 2	20.7%	21.1%	27.4%(1	34.5%(3	-9.1%(5

* The result is unreliable because kitchen waste was mixed with biowaste during the second measurement period.

1) Pay attention to amount of food prepared.

2) Pay attention to the storage of food (such as the amount of food stored, markings on stored food, order rhythm adjustment, quality of raw materials, reminder of FIFO principles to be visible to the staff).

3) Be more precise with serving food (such as monitoring the amount of food served and the size of the serving dishes).

4) Try selling the excess food at the end of the lunch hour.

5) FW posters and/or brochures in the dining area.

6) Information sessions for pupils.

7) Portion restrictions on the serving line (for example, indicating how many meatballs pupils can take).

Our study showed that a reduction of over 30% in food waste among food service outlets is possible with relatively simple measures. The most effective ones seemed to regard paying attention to storing of food, and placing food waste posters and/or brochures in the dining area. However, most of the food waste reduction measures seemed useful, while at least half of the outlets testing each measure succeeded in reducing food waste in the targeted areas.

Six outlets succeeded in reducing the amount of kitchen waste. This included four schools and two canteens with reductions of up to 100% at best. Four of the six outlets that were guided to *pay attention to the amount of food prepared* managed to reduce the amount of kitchen waste. In addition, all three food service outlets that were guided to *pay attention to the storage of food* (the amount of stored food and their markings for instance) managed to reduce the amount of kitchen waste.

Four food service outlets managed to reduce the amount of serving waste up to 57% at best. All eight outlets were instructed to *be more precise with serving food*, for instance to monitor the amount of food they serve and the size of the serving dishes. Two of three food service outlets willing to *try selling the excess food at the end of the lunch hour* managed to reduce the amount of serving waste.

Finally, six food service outlets managed to reduce the amount of plate leftovers up to 36% at best. Six of seven outlets that received *food waste posters and/or brochures to be presented in the dining area* managed to reduce the amount of plate leftovers. Secondly, *information sessions for pupils* were held in three schools. Among all of them, the amount of plate leftovers was at least reduced slightly. Four out of five schools that were guided to *add portion restrictions on the serving line* (for instance indicating how many meatballs pupils can take) managed to reduce the amount of plate leftovers.

4. Discussion

4.1. Theoretical and practical implications

This dissertation has brought up different perspectives on sustainable food systems and their development in Northern Ostrobothnia, Finland, by reviewing different sub-areas and embodiments of "sustainable food systems" as well as their development among different food chain operators (producers, consumers, food service sector) on a relatively small regional level, in the province of Northern Ostrobothnia, Finland. The selected sub-areas (local food logistics, consumer food-buying groups and food waste management) have been more prominent in recent years, both in policy strategies and in public debate. Additionally, I wanted to include topics throughout the system, from the different stages of the food life cycle, and to take into account perspectives from different actors operating in the system, to get a more comprehensive overview regarding this topic. In general, comprehensive, multi-input research regarding sustainable food systems and their regional organisation has been scarce, and its different sub-areas as well as food chain operators have often been examined separate from each other.

This dissertation gives an overview of what kind of policies/practices related to sustainable food systems exist in the region and how some identified "problems" could be solved. Each case offers some good practices and teachings that might benefit "the larger overall system". From a development perspective, the cases discussed in this dissertation represent different models of regional organisation. Article 1 represents mainly a theoretical review of possible logistics-related development activities, but the model presented is based on data from the field. Article 2, on the other hand, represents a consumer-driven development, as the food circles studied are, as a rule, set up by active consumers. The spread of food circles also takes place "in the field". Perhaps the weakness, in terms of their continuity, is precisely the lack of top-level management. Finally, in Article 3 development (reducing food waste) is based on both previous research and data from the field. This research has also allowed for practical testing of different measures, and good results have been obtained from the collaboration between research and practical actions.

These sub-studies summarise and reinforce the view that regional organisation and management of sustainable activities (including their continuation and development) is best achieved at multiple levels and through cooperation between different actors. However, this research confirms that a "sustainable food system" is a very multi-dimensional entity. I believe that identification of different

dimensions of a sustainable food system will be beneficial in the preparation of regional strategies and development projects in the future, for instance. Next, I will discuss in greater detail the theoretical implications this study has brought to light and also the benefits that the sub-studies might provide for society, businesses, and organisations.

This dissertation has had a practical policy approach to the emergence of sustainable food systems in the study area. As earlier mentioned, question of sustainable food systems can relate to several issues. Although my purpose was not to investigate the actual sustainability of the issues addressed or to explore the theory of a sustainable food system, it is evident that the sub-studies of this dissertation link up well with the definition of sustainable food systems. All core dimensions of sustainability (economic, social and environmental) underlie the themes discussed in this dissertation. They can be found behind the establishment of new distribution infrastructures for local food (Article I), alternative consumer-driven food supply chains (Article II), as well as behind the aim to reduce food waste (Article III).

The economic dimension of sustainable development is strongly linked to local food ideology in particular, and as some studies (e.g. Seppänen et al. 2006; Viitaharju et al. 2014) have shown, locally produced food has positive impacts on the regional economy. On the other hand, it is also linked to food waste. Issues related to economic sustainability can be found both in the context of food waste prevention and the use of surpluses already generated. For example, Hecht & Neff (2019) found several cases in their study that suggested promising effects of food rescue interventions regarding positive return on investment.

The social dimension of sustainable development is most clearly identifiable in the case of food circles, and as Dedeurwaerdere et al. (2017) have noted, collective food-buying groups seek to bring about societal change. Additionally, they are a way to achieve social and ecological goals (Forss and Kanninen 2013). However, many aspects of the social dimension of sustainability, such as traditions, labour condition and animal welfare, are issues that are often present behind local food ideology in general. Finally, in the case of food waste, the social dimension is particularly strong in food aid issues, which, however, were only briefly mentioned in this study.

The environmental dimension of sustainable development is perhaps the strongest of all the sub-studies of this dissertation. Especially, the carbon footprint was in focus. It was raised in the context of (centralised) local food logistics, but also in the logistics of food circles (especially by the frontmen). As previously mentioned, environmental impacts of transportation is one of the most common challenges of regional food supply chain logistics (Mittal et al. 2018). The carbon

footprint and unnecessary emissions (when food ends up as waste) will be discussed once again at the end of the food life cycle. As Dou et al. (2016) have noted, reducing food waste is a relatively simple measure that can improve food safety, generate economic savings and reduce the high environmental burden and emissions of food production.

The cultural dimension of sustainable development is strongly linked to local food systems. The Finnish Working Group on Local Food (Maaseutupolitiikan yhteistyöryhmä 2000) has stated that local food favours seasonality and takes advantage of regional food traditions in product development and marketing, for example. Different food-buying groups and cooperative styles of purchasing are also creating a new kind of culture.

Table 11 shows in more detail the clearest links between the sub-studies of this dissertation with the brief definition for sustainable food systems as it is presented in Story et al. (2009).

Table 11. Dissertation sub-studies and their links to definition for sustainable food systems as presented in Story et al. (2009).

	Article I (Korhonen et al. 2017)	Article II (Korhonen & Muilu 2022)	Article III (Korhonen et al. 2023)
Provides healthy food to meet current food needs	Aiming to meet the demand and supply of local food	Aiming to meet the demand and supply of local and organic food	-
Maintains healthy ecosystems that can also provide food for generations to come	-	-	Aiming to reduce the inefficiency of the food chain to meet the demand of the increasing world population
Minimal negative impact on the environment	E.g., aiming to reduce the environmental impact of transport	E.g., aiming to offer an opportunity to make environmentally friendly food purchases	Aiming to reduce unnecessary environmental impacts
Encourages local production and distribution infrastructures	New distribution infrastructures for local food	New distribution infrastructures for local and organic food	-
Makes nutritious food available, accessible, and affordable to all	Aiming to meet the demand and supply of local food	Aiming to meet the demand and supply of local and organic food	-
Is humane and just	Supports local producers and food companies (SMEs)	Supports local producers and food companies (SMEs)	-
Protects farmers and other workers, consumers, and communities	Aims to increase the transparency of the supply chain	Aims to reduce the need for middlemen, and increase the transparency of the supply chain	-

RQ1 (Article I: Korhonen et al. 2017) concerned the needs and possible solutions to improve local food logistics in Northern Ostrobothnia. The study was conducted at a time when there was a lack of academic research considering local food accessibility in the context of cooperative networks of small producers. In

fact, the updated National Local Food Programme (MMM 2021a) continues to highlight logistics as an important area for development.

Our surveys revealed the need of a local food wholesaler or other logistical feature integrating local products. The accessibility analyses showed the potential via a theoretical model, that local food collection could be handled effectively from a relatively large area by relatively modest and limited resources. More efficient transportation could be an added benefit by reducing the environmental impacts of transportation, while also concurrently maintaining transparency of the supply chain.

Information about favourable conditions for cooperative networks in the local food sector may help in establishing companies and their growth. Again, successful networking may increase scale economies in local production in transport, processing and marketing. "The spatial analytical market analysis framework" applied in this study is often implemented by large companies, but this type of strategic information could benefit also small farms and companies in the food sector. On the other hand, the model for improving the efficiency of local distribution infrastructures presented in this study could also be used to address security of supply issues.

One aim of this sub-study was to review opportunities to enhance and develop the local food value chain in sight of small producers. While we analysed how the intermediate-scale logistics would be functional to serve farmers, it was still important that the value chain meets the consumer's expectations for local food markets. We believe that the clustering opportunities represented in this paper would probably meet the expectations of the majority of consumers since the logistics remain in the market area, i.e., in the region (see definitions for local food in Chapter 2.3.1.). Also, joint transportation does not imply that the origin of the product becomes blurred, which is essential for consumers. The benefits would be particularly related to the reduced environmental impacts of transportation, while there would not be numbers of separate transportations. Also, the access of local food in institutional kitchens would improve from the viewpoint of supply volumes.

RQ2 (Article II: Korhonen & Muilu 2022) concerned the existence and evolution of alternative consumer-driven food supply chains in Northern Ostrobothnia. Little et al. (2010) have observed that such studies regarding food-buying groups and cooperative styles of purchasing would offer much, especially in terms of the historical context, future lessons for growth in the sector, and consumer motivation and ethics involved in buying groups. There are many examples of successful food co-ops and food-buying groups in Europe, as mentioned earlier (see Chapter 2.3.3.). However, in my opinion, the more populous and densely

populated Central Europe is not comparable to the sparsely populated Northern Ostrobothnia. Also, in Finland there are not many studies examining food-buying groups. Although, it seems that the interest in studying them has evolved just during the recent years following the increasing popularity of REKO rings.

One of the main principles behind consumer-driven food supply chains is meeting the demand and supply of local and organic food. Our study suggests that traditional food circles in particular have had an important pioneering role in Finland, as they have introduced the concept of collective buying, and making local and organic food more familiar to the consumer.

It is important to note that buying groups in general are a relatively new phenomenon in Finland, and they probably are still adjusting their format. Also, it seems that the geographical conditions (even within the same country), particularly the number and density of the population, affects what kind of buying groups successfully operate in a specific area. For instance, in the capital area in Finland, traditional food circles are more popular (see e.g. Kallio 2018). In addition to this, it should be noted that the conventional retail businesses have responded rather quickly to consumers' increased demand for local and organic food during recent years. The traceability of the products has clearly improved as well.

The improved availability of local and organic food in conventional acquisition channels has certainly reduced the need for food buying groups for many consumers. When the primary motivation for participation has been removed, overcoming the issues of access and affordability (see Little et al. 2010), other motivations are needed for new groups to be established or to keep the current ones viable. These kinds of groups are also very schedule-related which itself might be a threshold question for some consumers. We discovered in our study that viable action in food-buying groups requires unambiguous coordination and clear division of responsibilities, as well as participants who match the ideology of the group. All these points came true in the food circle that was still operating in a quite 'traditional manner'.

RQ3 (Article III: Korhonen et al. 2023) concerned the measures that have successfully reduced food waste among the food service sector in Northern Ostrobothnia. The results of the study are consistent with the findings of previous studies, confirming that it is possible to reduce food waste through various intervention measures. For instance, previously it has been identified that information campaigns have been effective in food waste reduction up to 28% (Reynolds et al. 2019). Our results considering plate leftovers were similar. Up to a 36% reduction was obtained after intervention, which included food waste posters and/or brochures in the dining area, information sessions for pupils and portion restrictions on the serving line.

The most successful interventions included in this study seemed to be *paying attention to the storage of food* to combat kitchen waste, *being more precise with serving food* to combat serving waste, and posting *food waste posters and/or brochures in the dining area* to reduce plate leftovers. However, most of the food waste reduction measures seemed to be useful, while at least half of the outlets testing each measure managed to reduce food waste of the targeted areas.

Our results verify the statement given by Filimonau et al. (2019) that the implementation of effective food waste management practices requires genuine corporate commitment to mitigate food waste. Two out of three of the foodservice outlets that reached the goal of reducing food waste by 30% maintained the average amount of food prepared per person or reduced it for the second measurement period. However, three outlets that prepared more food per diner during the second measurement period also had the largest increases in the amount of total food waste. Also the clear increased amount of serving waste among some outlets indicates that the instructions given to them (to be more precise with serving food) were not followed carefully.

Additionally, our results suggest that with a relatively short-term intervention it is slightly easier to influence customers than the routines of the kitchen staff. This conclusion is based on the fact that six of eight outlets managed to reduce the amount of plate leftovers and only four outlets managed to reduce the amount of kitchen waste and serving waste (which are both responsibilities of the staff).

Even though our study showed a reduction of food waste among food service outlets is possible with relatively simple measures, during our study we made some general observations regarding the more extensive challenges in managing food waste. Identifying and addressing these issues will be increasingly important in future development activities as some of these address the sustainability of the whole food chain and not just food waste among food service outlets.

Following the general food waste reduction guidelines and the waste hierarchy for food (see European Commission 2022) seemed to be challenging in different operational environments. Smaller actors and actors located in smaller municipalities might confront different infrastructural and logistical challenges, as is also acknowledged in the updated EU Waste Directive (EUR-Lex 2018). One problem has been the lack of biowaste collection. In fact, according to data from Finland (SBB 2021), the recycling rate of biowaste was 42% in 2020. Additionally, some responses to our survey reinforced the notion that the implementation of a waste hierarchy is not supported by the current infrastructure. However, the legislation regarding waste collection has recently been updated

(Valtioneuvoston asetus jätteistä 978/2021), and the National Waste Plan to 2027 (YM 2022) has set a target that 65% of all municipal biowaste should be recycled.

Another issue that emerged concerned selling surplus food from schools. In one case it was seen as unsuitable because it was thought that it would "steal" customers from a nearby restaurant. The donation of surplus food from schools to food aid was also difficult due to the lack of operators or logistical issues. However, it is important to note that food aid activities have improved notably after our study, especially in Oulu, and a new logistics centre for surplus food began operations in fall 2021 (HDL 2021).

Finally, one practical challenge considered private operators. From their point of view, consulting customers about their plate leftovers was a questionable practice due to "image-related" reasons.

4.2. Reliability and validity

This dissertation gives a brief overview of how sustainable food systems and their development are manifested in the study area, the province of Northern Ostrobothnia. It is based on two development projects: RuokaGIS & YLIKE. The research objectives of the projects, as well as previous Finnish studies related to local and organic food and food waste, were taken into account in the design of the surveys and interviews. A similar overview has not been done before in the region, nor elsewhere in Finland. However, as this is a case study, the results cannot be generalised beyond the study area. However, the themes discussed in the dissertation have also emerged in the national debate. Next, I will discuss in more detail the limitations of the sub-studies and the reliability and validity of the research.

The geographic information system (GIS)-based accessibility analyses that were used in the first sub-study (Article I, Korhonen et al. 2017) to analyse the potential for integral networking of local food production and transport companies are also applicable to all other types of foods. The method can be applied wherever suitable road networks and food production data are available. However, in practice, establishing these types of activities would be challenging for small-scale entrepreneurs due to the lack of information in relation to producers and resource requirements. Also, as mentioned earlier, in the case of Northern Ostrobothnia, the strengths of raw material production are in milk, beef, potatoes and cereals (Vuorela 2017), of which the first two generally require more processing and more stringent regulations related to transport from a food safety point of view.

Paciarotti & Torregiani (2021:437) have also brought up the following question in their review article regarding the logistics of the short food supply chains: *'Do farmers actually implement the clustering, logistics network integration, optimisation of collection/distribution centres and route optimisation approaches in their logistics activities and supply chain design?'*. In response, they emphasised the importance of detecting possible implementation barriers, as well as identifying practices and strategies to make research findings and developments more exploitable and applicable to and for the main actors of short food supply chains. In fact, one issue that occurred during the time our research was conducted was that many producers were still quite used to working on their own and cooperation could not be forced or persuaded. Further on, establishing this type of logistics activities would require more exploring of suitable operators and business models as well.

The second sub-study (Article II, Korhonen & Muilu 2022) covers a notable portion of Northern Ostrobothnian food circles and their members. The study reached 10 of 12 of the most well-known food circles and five other food circles during the time the surveys and interviews were implemented (2013–2014). However, there are a few issues that must be noted. Firstly, the exact number of food circles operating in the region remained unknown. There might have also been some smaller food circles that focused on a specific neighbourhood or work community. Secondly, the response rate for the survey could not be calculated, because the exact number of survey recipients was unknown (the survey link was distributed by the contact persons of each food circle). However, we estimated, based on the data given by the interviewees, that the survey responses covered about 13–19% of all households that participated in food circles in the study region during the time the data was collected. Thirdly, the analysis of REKO rings is based on the literature, which is still quite scarce.

The third sub-study (Article III, Korhonen et al. 2023) gives an overview of the previously unknown topic – the state of food waste management in Northern Finland. However, a few things need to be mentioned. Firstly, the food waste measurement periods that were implemented in the study gathered food waste data covering 101 days (or lunches). The number is good for an individual study but the sample is not statistically representative. Secondly, in this study, the food service outlet personnel kept diaries and weighed the food produced and wasted by following the instructions provided to them by researchers. Representatives of the food service personnel arranged the necessary briefing for the rest of the staff prior to the study period. As researchers briefed only one or two managers, who subsequently briefed the other staff, some confusion and misunderstandings may have occurred. However, this practice did not differ from other studies, and briefing all staff or having researchers carry out food waste measurements

would require much more resources. Thirdly, due to the low response rate of the survey, the answers cannot be generalised to the provincial level. However, they give some insights on the starting point of the study, while there has not previously been any targeted research of this issue in the area. Finally, it is difficult to identify the exact effect of each food waste reduction measure, because not all of them were tested by all of the operators. What was regarded as more important was that each reduction measure was selected with the operators themselves and that measures were targeted at the areas with the highest losses.

4.3. Recommendations for future research

According to the government report on food policy Food2030 (MMM 2017), the growth in global consumer demand for food and changes in consumer behaviour will pose major challenges, but also new opportunities for food system operators in the future. The population is becoming economically more unequal, is ageing and urbanising at an increasing rate. Changes in the geopolitical environment will have major impacts on world market prices and on food and security policy thinking. On the other hand, the importance of networking and cooperation will continue to grow, as will ethics, openness, and transparency throughout the food chain. Key challenges for the food system, in addition to ensuring the profitability and productivity of primary production and diversification, include environmental sustainability, the development of a circular economy, improving the competitiveness of the food industry and maintaining a high level of food safety. The challenges of food safety management, climate change and the low-carbon objectives of the EU's agricultural policy (CAP) are also changing the operating environment of the food chain in Northern Ostrobothnia.

Recent global (and local) events have also shown that some situations and their impacts on agriculture, rural areas, food production and food safety are unforeseeable. However, they bring many new and interesting topics for further research in the field of sustainable food systems regarding food logistics, food acquisition, household cooking, food waste management, etc.

The COVID-19 pandemic, for instance, increased household cooking due to lockdowns, and also brought a clear spike in the activities of REKO rings in many places (Möller 2022). In addition, the war in Ukraine has again underlined the importance of direct sales (Möller 2022). Also, the online sales and home deliveries by grocery stores and supermarkets have made acquiring food easier, and the use of such services has dramatically increased during recent years. According to MTV Uutiset (2022), online food sales grew 460% during the COVID-19 pandemic. In addition, its share is expected to multiply in the coming years.

Changes in consumers' shopping habits and acquisition channels they use, particularly regarding more sustainable options such as local and organic food, are interesting topics for research also in the future when changes in the operating environment are taken into account as well.

According to The Finnish Grocery Trade Association's press release (PTY 2022), surveys and studies show that as prices have risen, the importance of food prices has become more significant in consumers' everyday choices. Prices are being monitored more closely, consumers are choosing cheaper options and buying less. Bargains are favoured and "products to be discarded" sell well. With this in mind, the impact of rising food prices on food waste (and particularly on consumers' shopping habits regarding local and organic food) would also be a topical research subject.

Also, a more targeted research topic regarding food waste management would be the management of food waste among food circle / REKO ring members and local food producers. To my knowledge, no targeted research has been done on these topics. The importance of this kind of research is increasingly significant as local food gains more market share. In addition, it would be interesting to study the connection between the use of local food and food waste among the food service sector.

Another interesting topic for research would be the impact of energy and fuel prices on local food logistics and local food production overall. In a recent press release, The Finnish Food and Drink Industries' Federation (ETL) and The Central Union of Agricultural Producers and Forest Owners (MTK) stated that the uncontrolled rise in energy prices, especially electricity, will cause serious disruption of Finnish food production (ETL & MTK 2022). Their member surveys show worsening economic difficulties and production declines.

Above all, it would be necessary to invest in the realisation and implementation of SDG goals at the regional level, as the Prime Minister's Office (2023) has noted that Finland should boost action to achieve the 2030 Agenda goals. The guidance framework falls short of supporting cross-administrative guidance and of simultaneously taking ecological, social and economic sustainability into account in particular.

All in all, the sustainability of the food system is a very multi-dimensional entity, and based on the findings presented in this dissertation I suggest that areal differences and their potential for implementing different strategies should be taken into consideration more often in future studies. However, in my opinion, it would also be important to note that the overlap of different development programmes and strategies can increase confusion at the operator level.

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