Food waste in the Finnish food chain

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ABSTRACT

This study focused on mapping the volume and composition of avoidable food waste in the Finnish food production–consumption chain, and demonstrated that around 130 million kg of food waste are generated each year (23 kg per capita/year) from the household sector. Most of the discarded food was fresh and perishable, or leftovers from cooking and dining. Converted into greenhouse gases, the food discarded annually from Finnish households is approximately equal to the annual carbon dioxide emissions of 100,000 cars. The annual economic value of household food waste is about €70 per person. In the food service sector, the amount of waste ranged from 7% to 28% for cooked food, depending on restaurant type. In the entire sector it was estimated to be 75 to 85 million kg per year. Food waste was estimated to be 65–75 million kg per year in the retail sector. The entire food industry was estimated to produce around 75–140 million kg of food waste per year. Altogether, 335–460 million kg of food is avoidably wasted in the Finnish food chain (excluding primary production) per year.

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1. Introduction

Food accounts for over a third of the environmental impact of Finnish consumption. When examining the impact on climate alone, food (agriculture, the food industry, wholesale and retail, restaurants, and household activities) accounts for about a quarter of the climate impact of Finnish consumption, and the impact on the water system is even more pronounced due to eutrophication (Seppälä et al., 2011). Moreover, it is ecologically unsustainable to waste edible food rather than consume it. Improving resource efficiency in the food supply chain and consumption, as well as changing the general diet in Western countries, is vital to ensure future food supply for up to 9 billion people (e.g. Foley et al., 2011).

During recent years, there has been increasing international interest in the amount of food the world wastes. Research has mostly been carried out in Western countries, especially in households, but also in the entire food supply chain and system (e.g. BMELV, 2012; European Commission, 2010; Evans, 2012; Hanssen and Schakenda, 2011; Jones, 2005; Kantor et al., 1997; KFS, 2009; Knudsen, 2009; Parfitt et al., 2010; Schneider and Obersteiner, 2007; WRAP, 2008, 2009a, 2009b, 2010). It is argued that globally roughly one-third of food produced is lost or wasted, which amounts to about 1.3 billion tonnes per year (Gustavsson et al., 2011). Therefore, politicians are interested in food waste

and are seeking ways to reduce it (e.g. European Commission, 2010).

In most studies, food waste has been explored by conducting waste compositional analyses (e.g. Schneider and Obersteiner, 2007; Watanabe, 2009; WRAP, 2008), i.e. measuring food waste through the analysis of waste streams. A kitchen diary represents a different type of approach where a household member has to measure the amount of food wasted at the point of waste creation. Other food waste approaches include qualitative, guided interviews and the subtraction method, where difference between food purchases and consumption are calculated.

Composition analysis enables objective measurement of food, but barely allows analysis of the reasons behind the disposal of the food. The diary method enables the collection of background data on socio-demographics, behaviour and the attitudes of each household under study, and undertakes statistical analysis of the influences of these factors and reasons for the generation of food waste in different groups of households (Koivupuro et al., 2010; WRAP, 2010).

In Finland there have been no large-scale food waste studies encompassing the entire food supply chain. Only a few limited studies have examined the amount and sources of food waste produced by households, and the number of households involved in the studies has been minimal (Tarvainen, 2009; Koivupuro et al., 2010).

The aim of this paper is to determine the volume of avoidable food waste and its distribution among all parties involved in the Finnish food supply chain. Only the agricultural phase was excluded

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from the study. The research was specifically targeted at households, but the food service sector, industry and the retail sector were included in the study. At the household level, besides examining the quantity and types of food wasted, the aim was to analyse the reasons for food waste. Thus, for instance, the influences of different socio-demographic, behavioural and attitudinal factors on food waste were examined. The kitchen diary approach was applied to be able to meet these targets. In addition, this paper presents an estimation of the climate impact and economic value of Finnish household food waste.

2. Materials and methods

In this study we concentrated on avoidable food waste, i.e. all wasted food and raw material that could have been consumed had it been stored or prepared differently. Other bio-waste, such as vegetable peelings, coffee grounds or bones, was not measured. Of the liquid foodstuffs, we included milk, being an integral part of the Finnish food culture.

2.1. Household data collection and analysis

We collected the data in September 2010 by carrying out a kitchen diary study, mapping the volume and composition of food waste in Finnish households. In addition, we charted the demographic backgrounds of the respondents, including age, education and current life stage. Furthermore, we collected background information on, *inter alia*, eating and shopping habits, waste processing, opinions about food packaging, and we also evaluated the influence of these factors on food waste. The respondents were chosen from an online consumer panel.

A total of 420 households participated in the study, and of these, 380 households (1054 individuals) completed the study acceptably. The sample was not entirely representative of the Finnish population. Couples with children were overrepresented, while single-person households were underrepresented (see Table 1). Additionally, the households were situated in different geographic areas (the centre of a large city, suburbs of a large city, a small city or town, a smaller population centre and the countryside) in and around four cities (Helsinki, Turku, Tampere and Jyväskylä) located in southern and western Finland. Other aspects, such as household income, were also recorded, and the average income level was somewhat higher than average due to the average household size being higher than the Finnish average.

Prior to the study, the participants completed an online background questionnaire and they were equipped with electronic kitchen scales, as well as a diary and detailed instructions on how to

Table 1
Comparison of sample characteristics with Finnish population averages (edit. Koivupuro et al., 2012).

Characteristic	Sample of this study	All Finnish households in 2009
Household size		
• 1 person	15%	41%
• 2 persons	36%	33%
• 3 persons	21%	12%
• 4+ persons	28%	15%
Family/household type		
• Single-person household	15%	41%
• Couple without children	32%	28%
• Adult household	4%	7%
• Couple with children	42%	19%
• Single parent	6%	5%
• Family with children	48%	24%

weigh and record their waste and associated reasons for waste. The participants were instructed to behave as normally as possible concerning eating and wasting food during the diary study. The practical aspects of the study were carried out by a market research company, which also chose the participants from its own larger online panel. As an incentive, each participant was paid a small fee of €30 and was allowed to keep the electronic kitchen scales provided for weighing the food waste (valued at €20).

The study period was two weeks, and the results were recorded in the diary. The study was carried out in the autumn as the summer holidays were over and the next holiday season had not yet started. The households weighed their food waste daily, each time food was discarded. The diary had separate entries for each time food was disposed of, where the respondents entered not only the weight and type of food disposed of, but also the reason for disposal, such as 'spoiled' or 'past best-before date'. Diary entries were easy to make under headings such as 'bread', 'potatoes and potato products', 'home-cooked food' and 'convenience food', so that the respondent needed only to tick the corresponding box on the form.

The influences of several socio-demographic, behavioural, and attitudinal factors in relation to food waste were also studied. This was done through an extensive household background questionnaire. Due to the length of the questionnaire it was possible to analyse the influence of several factors in order to establish correlations, possibly unexpected, between food waste and household features. Most of the data were analysed using descriptive statistics and crosstabs. Subsequently a linear regression model was applied to the most promising factors to establish the statistical significance of the results. We formed *dichotomous variables* to include qualitative information in the model. We also formulated *dummy variables*, so that we could perform *regression analysis* using a categorical (*ordinal and nominal*) variable with more than two categories (Koivupuro et al., 2012).

2.2. Food service sector data collection and analysis

Two communal food service sector companies and a company responsible for catering for the restaurants of the University of Helsinki were partners in the study. The three companies had a total of 55 outlets, providing meals for various day-care centres, schools, hospitals, elderly service centres, and workplace restaurants and canteens. The study period for the food service sector lasted one week. Other restaurant and catering businesses, such as diners, restaurants, hotels, cafes, petrol stations and similar establishments serving meals, participated during a shorter, one-day research period. In total, the study covered 17 such businesses and there were 72 participating restaurants. The total number of research days was 292. Most of the outlets were schools and day-care centres (Silvennoinen et al., 2012b).

In restaurants, diners and food outlets, the food waste was measured by establishing the amount of food served, and weighing waste generated during cooking and serving, as well as customer leftovers. All restaurants participating in the study sorted and weighed leftovers. For the communal food service sector, the study was generally carried out at lunchtime, with the exception of elderly service centres and hospitals where dinner was considered. In cafes, petrol stations, diners and restaurants, the whole day was usually covered. After the restaurants closed, either the restaurant personnel or the researchers weighed the sorted waste. In addition, the personnel completed forms with the daily amounts of food prepared, and the amounts of food waste from cooking, service and leftovers.

Furthermore, the researchers studied the leftover content over 33 days in various outlets, establishing the composition and