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Carbon footprint of supermarket food waste

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ABSTRACT

Food waste is a major problem in modern society and carries considerable social, economic and environmental costs. Food production causes greenhouse gas emissions along the entire food supply chain and wasting food means that those emissions are produced in vain. There is consensus that food waste has to be reduced. For example, the EU and some of its member countries have set concrete targets to reduce the amount of waste. However, in order to achieve the overall goal of a more sustainable economy, not only quantitative but also environmental indicators have to be considered when pursuing waste reduction goals. This study analysed the discrepancies between the waste quantity and wastage carbon footprint (CF) profiles of perishable food products wasted in Swedish supermarkets.

The wastage CF, defined as the product CF from cradle up to and including delivery to the retailer times the amount of the product wasted at the store, was calculated for products in the meat, deli, cheese, dairy and fruit & vegetable departments of six Swedish supermarkets. The CF from cradle to retailer of the various products was determined based on existing life cycle assessment (LCA) literature. Emissions due to production and transportation were considered. Data on wasted mass of the products in the period 2010–2012 was provided by the Swedish retail chain Willys. Data on bread waste are mainly held by the bakeries, and were thus not included in the study.

Over a three-year period, 1570 t of fresh food (excluding bread) were wasted in the six supermarkets. The associated total wastage CF was 2500 t CO_2e. The fruit & vegetable department contributed 85% of the wasted mass and 46% of the total wastage CF. The meat department contributed 3.5% of the wasted mass, while it accounted for 29% of the total wastage CF. The wastage CF of each department tended to be highly concentrated in certain products and thus halving the waste of the top three products in each department could save more than 25 t CO_2e per store and year.

1. Introduction

Globally, about 1.3 billion t of food are wasted every year (Gustavsson et al., 2011). Besides economic, ethic and social aspects, food wastage carries a considerable environmental burden. The provision of food causes emissions of greenhouse gases (GHG) at all stages along the food supply chain (FSC), from input generation through agricultural production, post-farm processing and distribution to final consumption and waste disposal.

In Europe, the consumption of food accounts for about 20–30% of GHG emissions from consumption of all products, with the agricultural stage in the FSC being the key factor (Tukker et al., 2006; Moll and Watson, 2009). Agriculture is among the economic sectors with the highest environmental pressure intensities and resource use, and accounts for about 15% of direct GHG emissions from all EU (EU-25) production (Moll and Watson, 2009). The main GHG emissions at farm level are CH_4 emissions from livestock and N_2O emissions from soils and manure management (Moll and Watson, 2009). Globally, agriculture is the primary cause of increasing atmospheric concentrations of CH_4 and N_2O and produces 10–12% of total anthropogenic GHG emissions (Smith et al., 2007). In addition, the production of inputs such as fertiliser and energy use on the farm and for post-farm activities (e.g. transportation, processing, storage, refrigeration) leads to food-related emissions (Garnett, 2011; Sonesson et al., 2010).

Therefore, wasting food not only means that resources are wasted, but also that GHG emissions are produced in vain. According to FAO (2013) the global carbon footprint (CF) of annual food wastage is about 3.3 Gt CO_2 equivalents (CO_2e).

In the EU, about 90 Mt of food are wasted every year (Monier et al., 2010). Recently, the European Commission developed a "Roadmap to a Resource Efficient Europe". The food industry was identified as one of the key sectors and one of the milestones is for the amount of edible food waste in the EU to be halved by 2020

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(EC, 2011). So far, some individual countries have stipulated waste reduction targets which, however, partly still differ from the EU main goal. For example, Sweden aims to reduce food waste by 20% by 2020 compared with 2010 (SEPA, 2013), while the Netherlands has set a target of 20% by 2015 and France a target of 50% by 2025 (Rutten et al., 2013). All these targets refer to food waste in terms of mass.

Although food wastage occurs at all stages along the FSC, later stages such as households and the retail sector play a major role in industrialized countries (Gustavsson et al., 2011). In Sweden and other European countries, the retail sector is a highly concentrated industry (Axfood, 2012; Vander Stichele et al., 2006), which means that there are rather large supermarket chains instead of smaller, individual stores and therefore, food wastage is concentrated to certain locations. Moreover, the quality of the food wasted in stores is often still very high. Retailers are closely connected to other stages of the FSC and represent the link between producers and consumers. Therefore, addressing the retail sector is a key issue in order to reduce food wastage. Previous studies on food waste in the retail sector primarily focused on quantities of waste in terms of mass and identified fresh produce as the main contributor (e.g. Buzby et al., 2009). However, only evaluating wasted mass does not provide sufficient information about the environmental impact. In order to achieve the overall goal of a sustainable economy and to combat climate change, environmental indicators also have to be considered as regards food waste reduction goals. The aim of this study was to analyse wasted retail food in terms of GHG emissions, in order to obtain knowledge about the climate impact pattern of food waste in supermarkets. Specific objectives were to identify hotspots by determining the products and supermarket departments dominating the impacts and to quantify and illustrate the discrepancies between mass and CF profiles of the waste.

2. Material and methods

In order to analyse the climate impact pattern of retail food waste, the wastage CF was calculated for different food products wasted in six Swedish supermarkets. The wastage CF was defined as the specific CF value of a product, comprising emissions associated with the production and distribution up to delivery to the supermarket, multiplied by the total mass that was wasted in the stores of the respective product. Data on wasted mass were obtained as described in Section 2.1. The specific CF values were determined based on existing life cycle assessment (LCA) literature, as described in Section 2.2. For a detailed description of the background data see Scholz (2013).

The CF is expressed in terms of carbon dioxide equivalent (CO_2e). Here, CO_2, N_2O, and CH_4 emissions were included where the global warming potential of N_2O and CH_4 is expressed relative to CO_2 according to the IPCC (Solomon et al., 2007).

2.1. Food waste data

Data of food products sold or wasted at retail level were provided by the Swedish supermarket chain Willys, which supplied data for six of its stores. Willys, which is wholly owned by Axfood, is Sweden's leading discount chain, with a total of 174 stores (Axfood, 2012). The six stores participating in the study were selected by the company head office and are located in the Uppsala-Stockholm region. The sales area of the selected stores is between 2300 and 4900 m^2 (Eriksson et al., 2012) and the stores were considered to represent an average store of the retail chain in terms of factors such as turnover, profit and percentage waste (Eriksson, 2012). Willys stores generally carry approximately 9000 products (Axfood, 2012). This study analysed data on products in the meat, deli, cheese, dairy and fruit & vegetable department, i.e. the majority of the perishable products of the stores except bread and fresh fish. The bread department is managed separately by the supplier, while the fish department is relatively small and was not considered to contribute significantly to the food wastage. The departments are defined by the retail chain. The meat department sells fresh meat from terrestrial animals, mainly beef, pork and chicken, but also lamb and game meat. It also includes grilled chicken, raw sausages and some frozen meat. In the deli department, processed meat products such as sausages, meatballs and cold cuts, as well as black pudding and pâté, are sold. Besides dairy products such as milk, cream, butter and yoghurt, the dairy department also carries eggs, as well as drinks and juices based on fruit, vegetables and grain. The cheese department sells various cheeses, mainly hard or semi-hard cheese, soft cheese and cream cheese, but also tofu. The fruit & vegetable department sells a wide range of domestic and imported fresh produce.

Each store performs a daily waste recording routine where all products that are assumed to be unsellable, e.g. due to a passed best-before date, damage or colour change of the product, are collected. Where applicable, the European Article Number (EAN) code is scanned before the products are discarded, whereby the wasted mass is recorded. For unpacked fruit and vegetables, the estimated total mass or total number of items is entered manually. The items collected and discarded this way are referred to as in-store waste. The routine was already established by the stores before this study and is described in more detail by Eriksson (2012) and Åhnberg and Strid (2010). Unrecorded in-store waste and missing quantities as described by Eriksson et al. (2012) were not considered in this study.

However, some of the food discarded at Willys supermarkets is due to rejections upon delivery, which is defined as pre-store waste (Eriksson et al., 2012). Data on rejected products is logged into the supplier's accounting system manually every day and recorded in weekly reports. Since pre-store waste usually becomes physical waste at the retailer, it was included in this study. Data on pre-store waste was provided by the suppliers.

Data for the period 2010–2012 were analysed using Microsoft Excel 2010 and IBM SPSS Statistics 21. The wasted mass of a product or of a department was calculated as the sum of pre-store and in-store waste of all products belonging to the respective category. The wastage CF per year and store for each department was calculated as the mean of the six stores and the three years.

2.2. Carbon footprint of food products wasted in stores

The CF from cradle up to the delivery to the retailer of all products was calculated based on information from the literature. CF values as well as literature considered is listed in Tables 1–4. When more than one study on a specific product existed, the study that best represented the product at the store in terms of country of origin and production method and which used most current data was selected. Where the scope of the available literature did not exactly fit the purpose of the present study, assumptions or calculations were made as described in more detail in the following paragraphs. In general, all emissions associated with primary production, as well as emissions caused by processing and transportation up to the retailer, were considered. Emissions from land use change (LUC) were not included. Emissions associated with store operations and packaging were not included, since data availability was not sufficient and their impact was considered to be relatively low (Cederberg et al., 2009a; Stoessel et al., 2012).

2.2.1. Meat department

The total wasted mass for the whole meat department and for different product categories was calculated, including all fresh meat belonging to the respective category, also including imported,