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Environmental impacts of food waste in Europe

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ABSTRACT

Approximately 88 Million tonnes (Mt) of food is wasted in the European Union each year and the environmental impacts of these losses throughout the food supply chain are widely recognised. This study illustrates the impacts of food waste in relation to the total food utilised, including the impact from food waste management based on available data at the European level. The impacts are calculated for the Global Warming Potential, the Acidification Potential and the Eutrophication Potential using a bottom-up approach using more than 134 existing LCA studies on nine representative products (apple, tomato, potato, bread, milk, beef, pork, chicken, white fish). Results show that 186 Mt CO_2-eq, 1.7 Mt SO_2-eq. and 0.7 Mt PO_4-eq can be attributed to food waste in Europe. This is 15 to 16% of the total impact of the entire food supply chain. In general, the study confirmed that most of the environmental impacts are derived from the primary production step of the chain. That is why animal-containing food shows most of the food waste related impacts when it is extrapolated to total food waste even if cereals are higher in mass. Nearly three quarters of all food waste-related impacts for Global Warming originate from greenhouse gas emissions during the production step. Emissions by food processing activities contribute 6%, retail and distribution 7%, food consumption, 8% and food disposal, 6% to food waste related impacts. Even though the results are subject to certain data and scenario uncertainties, the study serves as a baseline assessment, based on current food waste data, and can be expanded as more knowledge on the type and amount of food waste becomes available. Nevertheless, the importance of food waste prevention is underlined by the results of this study, as most of the impacts originate from the production step. Through food waste prevention, those impacts can be avoided as less food needs to be produced.

1. Introduction

Food production is one of the key contributors to consumption-related environmental impacts in the European Union (EU). The primary production of food requires the use of resources such as fuels, land, water and raw materials that have associated economic and environmental impacts. Studies have shown that food contributes about 20 to 30% of the total impact of private consumption (Tukker et al., 2006). A major source of impacts is agricultural processes such as fertilizer application or livestock farming. Livestock farming produces significant environmental emissions in the form of methane derived from the enteric fermentation of ruminants. The application of fertilisers creates direct emission of nitrous oxides from soil processes. Both emissions contribute to climate change as do emissions related to energy for transport, storage and cooking of food in other steps of the food supply chain. Moreover, due to fertilizer application, ammonia is released as well as nitrogen oxides after the denitrification process in soils, which contributes to acidification and eutrophication. Emissions from manure storage and combustion processes also add to these environmental impacts.

The environmental impact of food production and consumption is further exacerbated when food is wasted rather than consumed. The FAO estimates that globally one third of food produced for human consumption is lost or wasted throughout the entire supply chain (FAO, 2011). Current estimates for the EU show that 88 Million tonnes (Mt) (±14 Mt) of food waste is produced along the supply chain, which is equivalent to 173 kg ± 27 kg per capita and year (Stenmarck et al., 2016). The environmental impacts of food waste cover all emissions deriving from the different steps of the food supply chain. The later in the supply chain a product is wasted, the higher are its environmental impacts, since all emissions coming from up-stream steps of the supply chain (e.g. production,

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processing, transport etc.) are included in the overall impact of the waste material. In other words, when food is wasted, then all associated activities and emissions created in the food supply chain upstream are therefore in vain. The environmental impact of food waste throughout the supply chain and subsequent waste disposal is considerable. Avoidable waste from the food supply chain results in unnecessary environmental impact from overproduction and processing upstream. Reducing avoidable wastes could reduce the amount of food production and it associated impacts overall. The UN Sustainable Development Goal 12.3 which targets a 50% reduction in food waste at the retail and consumer levels, in addition to reducing food losses along production and supply chains by 2030 can therefore serve as a significant step towards a reduction of environmental impacts due to food waste.

To understand the overall impacts of food waste and therefore to detect hotspots for future prevention activities, the impacts of waste throughout the supply chain as well as for different food products need to be determined more in detail. Studies on the environmental impacts of food consumption baskets (e.g. in Eberle and Fels, 2015; Foster et al., 2006; Notarnicola et al., 2017) have already provided some indications of hotspots in relation to food products. Those studies also highlighted the contribution of food waste to overall environmental impacts since food waste can be a high percentage of the initial weight depending on the specific food products. Consumption related studies have concluded that meat and dairy products make their major contribution to the environmental impacts in the agricultural sector (Audsley et al., 2009; Foster et al., 2006; Leip et al., 2015; Tukker and Jansen, 2006). The impacts from livestock farming contribute about 10% of the total GHG emissions from the EU-27 (Lesschen et al., 2011). In contrast, supply chain studies have shown that food consumption is of great importance regarding environmental emissions from vegetal food products (Foster et al., 2006). Indeed, the influence of the consumer behaviour (e.g. the way of organising shopping trips, storing of food in the refrigerator, energy demand for cooking) on the LCA results was identified as being highly relevant (Gruber et al., 2015).

Relatively few studies include waste management operations for food waste for the determination of environmental impacts. Food waste management can differ from country to country, and also from step to step of the supply chain, depending on the waste management strategy in use and also the type of food (vegetal or animal-derived). Different food waste management operations and their environmental impacts were assessed in Gruber et al. (2015) and Eriksson et al. (2015).

A range of studies have already addressed the issue of food waste and its environmental impacts in a national context (e.g. for UK in Quested and Johnson, 2009), for specific products (e.g. for tomato in Bernstad et al., 2017) or for different steps of the chain (Scholz, 2013; Brancoli et al., 2017; Quested and Johnson, 2009). Two studies are even available on a European (Monier et al., 2010) and a global level (FAO, 2013). Those existing studies especially on the bigger European or global level very often lack details on specific issues identified as important (e.g. waste management, consumer behaviour or even detailed information on specific food products). Therefore, within this study, a comprehensive approach was chosen; we have combined all relevant issues by using the most recent European food waste data in combination with an in-depth literature review to generate environmental impacts on food category level including waste management.

The goal of this study was to estimate the impact of food waste in relation to the total food utilised[1] in a European context, including the impact of food waste management based on current food waste data sets. The assessment of environmental impacts was performed under the EU project FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) which sought to contribute towards achieving a more resource efficient Europe through the significant reduction in food waste. Two approaches were used in FUSIONS, the bottom-up and top-down, to determine the overall impacts of food and food waste with a preliminary food waste data set elaborated in the same project (see Scherhaufer et al., 2015). This study comprises the findings of FUSIONS and conducts the assessment from the bottom-up on the basis of the food waste data from Stenmarck et al. (2016).

2. Methodology

2.1. Definition of food waste

The definition of food waste is often controversial and many different definitions have been developed (Schneider, 2013). To aid transparency, the system boundaries of the study need to be clearly described. Food waste can be classified into various categories (edible/inedible, avoidable/unavoidable). The classification into avoidable and unavoidable food waste is quite common, but still it is used inconsistently (Lebersorger and Schneider, 2011). A distinction between avoidable and unavoidable food waste is necessary to estimate the reduction potential of food waste by waste prevention (Huber-Humer et al., 2017). A harmonization of the definition of food waste is required and also set as a goal in the EU Action Plan for the Circular Economy (European Commission, 2015). In this study the term 'food waste' is that defined by Östergren et al. (2014). Food waste in this context covers both edible and inedible parts of food removed from the food supply chain excluding food used for biochemical and bio-based processes or for use as animal feed (Östergren et al., 2014).

2.2. System boundary

The assessment in the current study covers all impacts from cradle to grave, meaning all steps of the food life cycle including primary production covering agriculture, aquaculture and fisheries (PP), food processing and manufacturing (FP), retail and distribution including transport processes and packaging (RD) as well as food preparation and consumption (including out-of-home consumption) (FC) and food disposal (FD) at each step of the chain. Food waste is defined as food and inedible parts removed from the food supply chain which are not used for food conversion or valorisation (e.g. animal feed) (see Östergren et al., 2014). Food removed from the supply chain and fed to animals or used for biobased materials or biochemical processing, are considered as by-products or co-products in the current study. The end of life step of the food life cycle is defined in this study as food disposal (FD). Food disposal covers all waste management operations such as composting and anaerobic digestion, co-generation, incineration, landfilling but also other routes such as production of bio-energy and disposal via the sewer, plough-in/not harvested and any discards.

The food life cycle is furthermore classified into impacts deriving from different steps of the supply chain and impacts deriving from food which is eaten and food which is wasted. Fig. 1 shows the structure of the food life cycle and terms used in this study on the example of an apple. As the purpose of the product being assessed in this study is to eat it and not to waste it, the functional unit was chosen to be the amount of food eaten by an EU citizen. The mass flows are referred to this unit.

It is explained on the example of 1 kg of food (in this case apple) eaten by a consumer and illustrated in Fig. 1: Food waste related emissions cover all emissions which are released in

[1] Defintion by FAOStat: Production + imports – exports + changes in stocks (decrease or increase) = supply for domestic utilization