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Review

Current practice, challenges and potential methodological improvements in environmental evaluations of food waste prevention – A discussion paper

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ABSTRACT

A review was performed of eight previously performed investigations of environmental impacts from end-consumer food waste prevention. The overall aim of the study was to investigate the state of the art in these assessments, identify key factors which could explain seen variations in GWP-emission savings, and suggest methodological improvements leading to increased potentials for cross-study comparisons. Avoided emissions of greenhouse gases can according to reviewed studies reach from 0.8 to 4.4 kg CO_2-eq./kg prevented food waste. The review shows that differences in calculated environmental benefits largely can be explained by emissions from avoided food production and related services, rather than avoided management of generated food waste. Thus, variations in previous studies are largely explained by differences in system boundary delimitations and assumptions related to the avoided food supply system. The review supports that food production is the overall determining factor for benefits related to food waste prevention in reviewed studies. In addition, consumer transports and end-consumer preparation can have a large impact on overall results, mainly due to the relatively small amount of food transported/prepared per unit energy consumed. The importance of a specific process in the food supply chain on overall results will however depend on several different parameters, such as environmental profile of energy used for cooking. The present study also discusses food categories of relevance to differentiate between when addressing the composition of preventable food waste, with the general recommendation to differentiate between vegetables/fruit, bread, cheese, other dairy products, fish, meat (beef) and meat (other than beef). As the many assumptions necessarily made in assessment of prevented food production have a large impact on the overall results, it is recommended for the LCA-practitioner to clearly present made assumptions. In addition, use of sensitivity analyses, varying the composition of prevented food waste is useful for robustness check. Due to the current diversity in methodological approaches when assessing environmental benefits from food waste prevention, authors would welcome establishment of more detailed guidelines within this field in order to increase both the general quality in assessments as well as the potential for cross-study comparisons.

Contents

Abbreviations: LCT, lifecycle thinking; LCI, lifecycle inventory; LCA, lifecycle assessment; FU, functional unit; FSC, food supply chain; WMS, waste management system; WFD, waste framework directive; GHG, greenhouse gas; GWP, global warming potential; PEU, primary energy use.

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1. Introduction

Several studies have in later years stated that large parts of the food waste[1] currently generated in the world is composed of food which has been wasted although perfectly useful for human consumption (Obersteiner and Schneider, 2006; Ventour, 2008; Jensen et al., 2011; FAO, 2011; Watanabe et al., 2011). This trend is contradictory to the EU Waste Framework Directive (WFD), which clearly states that waste prevention should be the first priority in waste policy making in member states and that prevention is the first step in the waste hierarchy (European Parliament, 2008). At the same time, management of generated food waste within the EU will, in line with the EU WFD and EU Landfill directive (European Parliament, 1999), in coming years become increasingly focused on energy and nutrient recovery, as opposed to landfilling. Several previous studies have investigated the environmental impacts from different alternatives for food waste management, using life-cycle assessment (LCA), showing avoidance of net-emissions of greenhouse gases (GHG) and other environmental impacts through energy and nutrient recovery from food waste through anaerobic digestion, incineration, composting or landfill with gas collection (Levis and Barlaz, 2011; Manfredi et al., 2011; Andersen et al., 2012; Zhao and Deng, 2014). Thus, food waste minimization will not only provide environmental benefits, but can also decrease potential environmental benefits related to efficient food waste management. In order to capture the balance between benefits and losses related to food waste prevention, both systems must be studied with a holistic approach or from a life-cycle thinking (LCT) perspective (ILCD, 2011). Guidance on best practice in lifecycle assessment (LCA) of food waste management has been presented (ILCD, 2011). However, there is still little guidance of how assessments of environmental benefits related to food waste prevention should be performed.

1.1. Aim and scope

In the present study, a number of methodological issues of importance in the assessment of environmental evaluations of food waste prevention by end-user or consumer are discussed. System boundary setting is discussed with the aim of identifying aspects, which are of relevance to consider, within the production as well as waste management system. Relevant levels of aggregation in estimations of prevented food waste as well as inclusion of potential rebound and cascading effects are discussed. Authors also present suggestions, which could increase consistency and comparability between studies future within this area, with the intention to contribute to improved insight of some of the difficulties when performing LCA of food waste prevention, and thereby facilitating future studies.

[1] The term food waste is in the present paper used in relation to foodstuff that has been wasted by end-consumers, in line with the definition used by FAO (2013). In addition, inedible parts of foodstuff is included.

2. Materials and method

A review of scientific literature and a number of public reports focusing on food wastage was performed. The terms used in the literature search were *food waste|food loss* in combination with the terms *prevention/minimization/reduction* and *lifecycle assessment/environmental impact assessment*. In order to compare different methodological choices made in the different studies in relation to resulting environmental impacts, only studies where results were presented in qualitative terms in relation to greenhouse gas emissions (GHG) or primary energy use (PEU) were selected. Another criterion in the selection process was only including studies with focus on losses on end-consumer level. The aim of the study was however not to perform a comprehensive review of previously presented publications on this topic, but rather to discuss methodological approaches of importance to the results of this type of studies. The eight selected studies addressed in the present paper are presented below:

- Bernstad and Andersson (2015) compare GHG-emissions related to household food waste prevention compared to incineration or separate collection and subsequent anaerobic digestion.
- Cuéllar and Weber (2010) investigate the embedded energy in US household food waste.
- Gentil et al. (2011) use life-cycle assessment (LCA) methodology to compare waste prevention related to un-solicited mail, food waste and use of reusable glass bottles, to different waste treatment alternatives.
- Gruber et al. (2014) investigates environmental impacts related to wastage of three different types of foodstuff in Germany, using LCA methodology. The study covers the food production system and different options for waste management; composting and incineration.
- Matsuda et al. (2011) compare GHG-emissions related to current solid household waste management (incineration), separate collection with anaerobic digestion and MBT with anaerobic digestion to three alternatives for food waste reduction; home composting, use of in-sink food waste disposers and food waste prevention.
- Mogensen et al. (2011) present greenhouse gas (GHG) emissions related to Danish household, manufacturing and retail food waste.
- Venkat (2011) use LCA methodology to assess the climate change impact of food waste in the US.