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Food waste accounting along global and European food supply chains: State of the art and outlook

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ABSTRACT

Contributing to environmental pollution and resources depletion, food waste represents a considerable inefficiency of the global food system. Within the United Nations Sustainable Development Goal 12.3, countries committed to halve per-capita food waste generated at retail and consumer levels and to decrease food waste along the food supply chain by 2030. Reliable and detailed information on food waste is of utmost importance for the actors of the food supply chain, organizations and governments willing to implement and monitor effective reduction strategies. The present paper is a review of existing studies on food waste generation at the global and European scales and aims primarily at describing and comparing the approaches adopted, and secondarily at analysing their potential in supporting food waste related European interventions and policies. Ten studies were selected among relevant scientific papers and grey literature and their underlying quantification methodologies were systematically analysed. Methodological elements discussed in the paper include type of waste streams captured by estimations, distinction between edible and inedible food waste along the agro-food supply chain, reported units of measure, overall inefficiencies of the food system, and uncertainty of data. Current estimations of food loss and waste generation range between 194–389 kg per person per year at the global scale, and between 158–298 kg per person per year at the European scale. However, further efforts are needed to improve their level of detail and reliability and to foster their support to food loss and waste-related strategies.

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1. Introduction

About one third of the food produced for human consumption is currently wasted at the global scale (FAO, 2011). Food waste (FW) generation, happening throughout the entire food supply chain around the globe, is dominated by different dynamics, ultimately associated by the same unsustainable paradigm. Wasting food contributes to environmental pollution as well as to natural resources degradation and depletion, threatening food security (Foley et al., 2011). Therefore, FW is one of the targets of both environmental and food security policies at different scales. According to the United Nations Sustainable Development Goal (SDG) 12.3, per-capita FW at retail and consumer levels should be halved and FW along the entire food supply chain should be reduced by 2030 (UN, 2015). The European Commission, beyond having committed to the SDG 12.3 reduction target on FW, has included FW among the priority areas of the Circular Economy Action Plan, and is committed to define a common EU methodology for FW accounting and to propose relevant indicators (EC, 2015).

Being aware of the amount of FW generated is the first step to support effective prevention and reduction strategies, and to unveil the potential for FW cascading use from a circular economy perspective. Such information, indeed, allows: (i) defining a baseline to monitor FW reduction over time, (ii) identifying the most important FW streams in terms of mass, (iii) prioritising prevention and reduction interventions, and (iv) highlighting which FW flows may undergo a valorisation process in a circular economy perspective (Caldeira et al., 2017).

In the last years, FW quantification has arisen considerable interest, reflected by the increasing availability of data on FW generation along the food supply chain at various geographical scales. At international level, in 2016, a multi-stakeholder partnership delivered a guidance for quantifying food and associated inedible parts removed from the food supply chain (Hanson et al., 2016). The project FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) (FUSIONS, 2016), carried out between 2012 and 2016 and founded by the 7th Framework Program of the European Commission, represents a milestone for FW accounting. Two of the main outcomes of the project were a manual on FW quantification (Tostivint et al., 2016), and an estimate of FW generated at the European level (Stenmarck et al., 2016). Roodhuyzen et al. (2017) made a comprehensive review on definitions and approaches for research on FW, but they excluded quantitative considerations from their study. Xue et al. (2017) made a broad review of existing literature on FW quantification, including an analysis of the bibliometric characteristics, and the assessment of advantages and disadvantages of methods used to measure FW. They found that most of the studies on FW generation were based on literature data and statistics. However, relying on such sources of data may undermine the robustness of resulting considerations. Indeed, the underlying definitions of FW, the system boundaries, and the methods for data collection have a considerable influence on FW quantification (Bräutigam et al., 2014). Furthermore, Gustavsson et al. (2013) highlighted that the FW quantification study by the Food and Agriculture Organization of the United Nations (FAO, 2011), often taken as a reference in subsequent studies (Xue et al., 2017), included several assumptions due to lack of data. Methodological gaps, particularly concerning the accounting of liquid FW and fractions of FW used to feed animals, were emphasised by Møller et al. (2014). Combining these elements, and the fact that data are in some cases outdated (Parfitt et al., 2010), Xue et al. (2017) pointed out the potential scarce representativeness of literature data for specific countries or food commodity groups.

The primary aim of the present paper is to describe and compare the approaches adopted by different methods to account for FW generation as well as their implications on the results. The analysis was performed at the global and European scales because of data availability and the existence of studies based on different methodological approaches. Secondarily, it aims at discussing the potentialities of these methodological approaches in supporting European interventions and policies on FW.

In literature, there are different definitions of the terms food loss and food waste. For the purposes of the present paper, the term FW is intended to include all the food streams, encompassing edible and inedible fractions, leaving the food supply chain, at any stage, from production to consumption.

2. Materials and methods

According to their scope, FW estimations may report data for different geographical scales and levels of details in term of breakdown of the supply chain (Fig. 1). The focus of the present study is on the global and the European scales. Hence, national studies were excluded from the analysis because the focus was on FW accounting methodologies, considering as well the effects of methodological choices on results. Including national studies would have added variability in the results due to different socio-economic and cultural contexts, limiting the possibility to compare methodologies in light of the results of the accounting.

A literature review has been performed using the bibliometric database Scopus (www.scopus.com). Preliminarily, a screening of the documents including the keywords "food loss" AND "Europe" OR "EU", "food waste" AND "Europe" OR "EU", "food loss" AND "global", "food waste" AND "global" within the title, abstract or keywords was done. The search was bound to papers published or available in Scopus database from January 2005 and June 2017. A refinement of the selection of papers was accomplished, considering titles and, if necessary abstracts, according to the following criteria: (i) the study reported an estimation of FW generated either at European or global scales, based on statistics or proxies; (ii) the study included an overall estimation of FW and it did not focus on a single product; (iii) the estimation interested at least one of the life cycle stages from food manufacturing and consumption; (iv) the amount of FW was expressed in terms of mass. Furthermore, since a large amount of data on FW is reported within scientific reports, we explored as well the grey literature on the topic starting from the analysis of the reference lists reported in selected documents, adopting the abovementioned selection criteria.

The selected studies were reviewed on the basis of elements identified within the FW quantification manual of the FUSIONS project to assess the quality of existing FW estimates (Tostivint et al., 2016), complemented with other relevant aspects. The review focused on: aims of the studies, FW definitions, data sources and quantification approaches, breakdown in product groups, and reliability of estimates. Finally, the results for each stage of the food supply chain were analysed and compared. For such purpose, the results were expressed on a per capita basis considering the global or European population reported respectively in FAOstat (FAO, 2017) and Eurostat (2017a) for the year of estimation. Furthermore, the breakdown of the food supply chain in the following stages was considered: primary production (including post-harvest), manufacturing, distribution, and consumption.

3. Results

The keywords research in Scopus database led to the identification of 480 peer-reviewed papers. Among these, five peer-reviewed papers (Table 1) were shortlisted for the analysis according to the