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Food waste quantification in primary production – The Nordic countries as a case study

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ABSTRACT

Our understanding of food waste in the food supply chain has increased, but very few studies have been published on food waste in primary production. The overall aims of this study were to quantify the total amount of food waste in primary production in Finland, Sweden, Norway and Denmark, and to create a framework for how to define and quantify food waste in primary production. The quantification of food waste was based on case studies conducted in the present study and estimates published in scientific literature.

The chosen scope of the study was to quantify the amount of edible food (excluding inedible parts like peels and bones) produced for human consumption that did not end up as food. As a result, the quantification was different from the existing guidelines. One of the main differences is that food that ends up as animal feed is included in the present study, whereas this is not the case for the recently launched food waste definition of the FUSIONS project.

To distinguish the 'food waste' definition of the present study from the existing definitions and to avoid confusion with established usage of the term, a new term 'side flow' (SF) was introduced as a synonym for food waste in primary production. A rough estimate of the total amount of food waste in primary production in Finland, Sweden, Norway and Denmark was made using SF and 'FUSIONS Food Waste' (FFW) definitions. The SFs in primary production in the four Nordic countries were an estimated 800,000 tonnes per year with an additional 100,000 tonnes per year from the rearing phase of animals. The 900,000 tonnes per year of SF corresponds to 3.7% of the total production of 24,000,000 tonnes per year of edible primary products. When using the FFW definition proposed by the FUSIONS project, the FFW amount was estimated at 330,000 tonnes per year, or 1% of the total production.

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1. Introduction

There is continuing pressure to produce more food due to population growth. Simultaneously, there is need to reduce our impact on the environment (Rockström et al., 2009). Resource efficiency and food waste minimization are essential means to reduce environmental impact while improving food security (Godfray et al., 2010). The European Commission has recently launched a plan (European Commission, 2016) that supports the UN target of halving the amount of food waste at the retail and consumer levels and reducing food losses along production and supply chains,

including postharvest losses, by 2030 (UN, 2016). The plan covers the whole food supply chain. While it is argued that in western countries the greatest potential for reducing food waste is in retail, restaurants and households (Parfitt et al., 2010), it is essential to consider all stages of the food chain, hence also primary production and processing. Neglecting one stage, like primary production, can negatively impact the overall aim of reducing total food waste. For instance, strict quality standards may reduce food waste in retail, but instead increase food waste in primary production (Bond et al., 2013). Hence, it is difficult to develop strategies for preventing food waste if there is a lack of comprehensive knowledge on how much, why, and where food is removed from the food supply chain.

Several food waste studies have been carried out within and outside Europe in the last few years according to a literature review by Møller et al. (2014), but only a few of the studies have

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focused on primary production (Beretta et al., 2013; Franke et al., 2013; Gustavsson et al., 2011; Hartikainen et al., 2014; Redlingshöfer et al., 2017; Roels et al., 2010). Some recent studies also claim that there is still a great need for studies on food waste in primary production (Chaboud, 2017; Redlingshöfer et al., 2017). Redlingshöfer et al. (2017) argue that there is a demand for more detailed, systematic and consistent data about food waste from primary production.

Most of the existing studies on food waste in primary production are national and relate to only one type of product at a time, typically an open field vegetable or a crop, such as potatoes or wheat (Chaboud, 2017; Møller et al., 2014; Willersinn et al., 2015). There are only a few national studies on food waste in primary production covering several food products (Beausang et al., 2017; Beretta et al., 2013; Hartikainen et al., 2014; Redlingshöfer et al., 2017). The Food and Agriculture Organization of the United Nations (FAO) report (Gustavsson et al., 2011) estimates food losses in seven product categories at five stages of the production chain (one of them being primary production) in seven regions of the world. However, the food waste figures on primary production in the FAO report are based on a very limited and dated set of data (Chaboud, 2017).

This lack of studies might be because food waste in primary production differs in many ways from the rest of the food chain. Food waste at this stage is often put to good use, such as animal feed, whereas food waste at the later stages is not always used as efficiently, which especially applies to municipal waste. Another distinguishing factor is that food waste in primary production is often caused by external factors (Beausang et al., 2017; Gustavsson et al., 2011), such as weather conditions and diseases, whereas in other parts of the food supply chain food waste is more dependent on internal factors, such as bad planning (Stensgård and Hanssen, 2016). Additionally, in primary production it may be unclear at what point the product can be labelled as 'food', and thus when the waste can be labelled as 'food waste'. Stenmarck et al. (2016) combined food waste studies from different stages of the food chain from several European countries, and according to them food waste is the hardest to analyse and quantify for primary production.

The food waste reduction targets, such as the target set by the European Commission, involve the entire food supply chain. Evidence from the few studies that have been done in the primary production sector (Beausang et al., 2017; Beretta et al., 2013; Franke et al., 2013; Gustavsson et al., 2011; Hartikainen et al., 2014; Redlingshöfer et al., 2017; Roels et al., 2010) shows that there is a significant amount of food waste in primary production – especially in plant production. Thus, there is a definite need for a better understanding of food waste in primary production.

There is no internationally agreed definition of food waste, but at least two international initiatives have developed a manual for quantifying food waste. One is the Definitional Framework for Food Waste (FUSIONS definition) (Östergren et al., 2014), which was developed within the EU FUSIONS project and focused on quantifying the total amount of food waste at national level within the EU. The other is the Food Loss and Waste Accounting and Reporting Standard (FLW Standard) (WRI, 2016), a global accounting and reporting standard which enables a wide range of entities to account for and report how much food waste is created and to identify where it occurs. However, it is argued here that these two guidelines do not cover all aspects of primary production. As argued by Chaboud (2017) and the FLW Standard (WRI, 2016), the scope of the study determines what is included in food waste and what is not. The present study and the two other guidelines have different scopes, and consequently the amount of food waste quantified differs depending on which of the three guidelines is used.

The present study has multiple purposes. Firstly, the study presents new case study results on food waste in primary production for products where limited data exists. Secondly, the study suggests a new definition for food waste and a methodology to quantify edible food waste in primary production. The study also compares the new definition to the existing guidelines – the FUSIONS definition and the FLW Standard, and other similar studies – and discusses the differences. Thirdly, the study presents the results for food waste generated in primary production in Nordic countries using both the new definition and the FUSIONS definition. Fourthly, the results of this study on food waste in primary production are further compared to the results of other studies on food waste in primary production (e.g. to the FAO report). Fifthly, one aim is to highlight and discuss some of the key features of food waste quantification, such as the importance of the scope of the study and its reflection on study design and results.

2. Material and methods

2.1. System boundaries and definitions

The system boundaries and definition for food waste in primary production in the present study are different from the existing studies. In fact, there are no common system boundaries and definition for food waste in primary production in the literature. For instance, Gustavsson et al. (2011) includes losses during the rearing phase of animals in the system boundary. Meanwhile, several other studies exclude these losses and start the study when the animal is ready for slaughter (Beretta et al., 2013; Redlingshöfer et al., 2017; Stenmarck et al., 2016). In the present study, the system boundary is:

Agriculture, aquaculture and fisheries, starting from when plants are ready for harvest, farmed fish are hatched, animals are born, milk is drawn and eggs are laid. The system ends when the product is sent for processing or to wholesale/retail.

[Fig. 1]

The definition of 'food waste' also varies in the literature. WRAP (2008) has proposed a division of food waste into avoidable, possibly avoidable and unavoidable food waste, where avoidable waste is what is commonly consumed, possibly avoidable is something that could be consumed (e.g. peels), and unavoidable is something that cannot be consumed (e.g. leaves). Meanwhile, some studies only focus on the edible part of food waste that was intended for human consumption (Beretta et al., 2013; Redlingshöfer et al., 2017), and some include both inedible and edible parts in food waste (Stenmarck et al., 2016). Moreover, the destination of the food waste can determine whether it is considered waste or not. For example, Stenmarck et al. (2016) and Redlingshöfer et al. (2017) excluded food waste recycled into animal feed from the definition. In the present study, food waste in primary production is defined as follows:

The flows of primary products that were meant to be eaten by humans, but never entered the next step in the food supply chain (e.g. slaughter, retail, processing), and instead were used for other purposes (e.g. feed) or sent for waste treatment. Non-edible parts (not intended for human consumption) of wasted food, e.g. peels and bones, are not included in the definition.

Moreover, the terminology varies in the literature. The most commonly used terms in literature are 'food waste' and 'food loss', but WRAP (2008) also introduced terms 'avoidable', 'possibly avoidable' and 'unavoidable' food waste. In addition, the term 'food wastage' is used in some studies (Corrado et al., 2017). A new term,

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