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Quantifying food losses and the potential for reduction in Switzerland

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ABSTRACT

A key element in making our food systems more efficient is the reduction of food losses across the entire food value chain. Nevertheless, food losses are often neglected. This paper quantifies food losses in Switzerland at the various stages of the food value chain (agricultural production, postharvest handling and trade, processing, food service industry, retail, and households), identifies hotspots and analyses the reasons for losses. Twenty-two food categories are modelled separately in a mass and energy flow analysis, based on data from 31 companies within the food value chain, and from public institutions, associations, and from the literature. The energy balance shows that 48% of the total calories produced (edible crop yields at harvest time and animal products, including slaughter waste) is lost across the whole food value chain. Half of these losses would be avoidable given appropriate mitigation measures. Most avoidable food losses occur at the household, processing, and agricultural production stage of the food value chain. Households are responsible for almost half of the total avoidable losses (in terms of calorific content).

1. Introduction

Food loss over the entire food value chain represents a significant loss of resources invested in food production, transport, and storage. Since resources (land, energy, fresh water, agricultural inputs) are limited in nature, they should be applied efficiently and sustainably. Further negative externalities of food production include ecotoxicity from pesticides, eutrophication, soil erosion, organic matter loss, and biodiversity loss (Pretty, 2005). Between 20% and 30% of the environmental impact of products is caused by food consumption (Tukker et al., 2006). Thus, food loss may cause substantial environmental impact. Furthermore, economically avoidable food losses are of high importance in the efforts to combat hunger and to improve food security, not only in developing but also in developed countries. Improving the efficiency of the food value chain could help bring down the cost of food to the consumer and thus increase access for low-income households (Gustavsson et al., 2011). A multidisciplinary research project in the UK found that reducing food losses across the entire food value chain will be a critical component of any strategy to sustainably and equitably feed the rapidly growing global population (Foresight, 2011).

A survey from the Swiss Federal Institute of the Environment (Baum and Baier, 2008) analysed the flows of biogenic goods in Switzerland. The results show that 1.8 mio. tonnes of plant products and 0.1 mio. tonnes of animal products (dry matter) were consumed in 2006. Baum and Baier (2008) also analysed various flows of disposal, but without differentiating between food and other biogenic goods. The most extensive statistical analysis of food consumption in Switzerland is carried out annually by the Swiss Farmer's Union (SBV, 2009). The analysis encompasses agricultural production, import, export, storage variation, and consumption at the retail level.

Two recent publications estimate food losses over the entire food value chain from agricultural production to final consumption. According to Lundqvist et al. (2008), 1400 kcal/capita are lost globally every day. Gustavsson et al. (2011) differentiates between seven regions, one of them being Europe. Here, the avoidable losses are estimated at 280 kg/cap/a.

A "preparatory study on food waste across the EU 27 Member States" (Monier et al., 2010) estimates the food losses in each country, based on the EUROSTAT database, a literature review, stakeholder consultations, and specific hypotheses. The losses over all stages of the food value chain except agricultural production are estimated between less than 50 kg/cap/a (Greece) and more than 500 kg/cap/a (Netherlands), with an average of 180 kg/cap/a for EU 27. The major contribution is from households (42%).

The most recent study at a national level was carried out in Germany, induced by a report of the European Parliament on how to avoid food losses and on strategies for a more efficient food value chain in the EU (Caronna, 2011). The study quantifies the amount of food losses over all stages of the food value chain except agricultural production. They estimate food losses in Germany to be between 8 and 15 mio. tonnes per year (100–180 kg/cap/a, calculating with a population of 82 mio.). The major contribution is

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from households (61%), followed by the processing and the food service industry (17% each) (Kranert et al., 2012).

In Switzerland, quantitative data about food loss is incomplete and rare. A market study from 2001 by McKinsey & Company estimated the losses from the retail sector, based on the consultation of several food companies. The result gives a rough estimate of 14–36 kg/cap/a (numbers refer to fresh substance); 10% of this amount is estimated to fulfil qualifications for food donation to underprivileged people (Schweizer-Tafeln, 2010). In the Canton of Aargau, 21 kg/cap/a were wasted in 2007 from the food service industry alone (Baier and Reinhard, 2007). In the Canton of Bern, the corresponding amount has been estimated at 19.4 kg/cap/a in 2005 (Andrini and Bauen, 2005).

Data on food losses in Swiss households are lacking, despite their importance. A large study performed in the UK, based on a physical waste analysis of 2138 households, illustrated that the avoidable and possibly avoidable losses correspond to 17.7% of the weight of the food and drink purchased; the food losses, excluding drinks, make up 21.3% of the purchases (Quested and Johnson, 2009). Another study in Germany, based on online diaries in 200 households, concluded that 12% of food purchased by households is lost (Cofresco, 2011).

The goals of this paper are: (a) to quantify the scale of food loss in Switzerland across the entire food value chain from agricultural production (harvesting) to final consumption (intake) and with differentiation into a number of relevant food categories, (b) to group them into avoidable, possibly avoidable, and unavoidable losses and (c) to suggest some initial measures for the reduction of food losses.

2. Methodology

2.1. Definitions

In the literature food losses are defined in different ways. The definition employed in this paper refers to food which is originally produced for human consumption but then directed to a non-food use or waste disposal (e.g. feed for animals, biomass input to a digestion plant, disposal in a municipal solid waste incinerator).

Food losses are grouped into three categories, based on the definitions in Quested and Johnson (2009):

(1) *Avoidable losses* refer to food and drink thrown away because they are no longer wanted, e.g. because they perished or exceeded their date of expiry. Most avoidable losses are composed of material that was, at some point prior to disposal, edible, even though a proportion is not edible at the time of disposal due to deterioration (e.g. rotting, decomposition).
(2) *Possibly avoidable losses*, in contrast, refer to food and drink that some people eat and others do not (e.g. apple peels), or that can be eaten when prepared in one way but not in another (e.g. potato or pumpkin skins), or that is sorted out due to specific quality criteria (e.g. bent carrots).
(3) *Unavoidable losses* comprise waste arising from food and drink preparation that is not, and has not been, edible under normal circumstances. This includes apple cores, banana skin, tea leaves, coffee grounds, and inedible slaughter waste. Additionally, harvesting, storage, transportation, and processing losses that are not avoidable with best available technologies and reasonable extra costs are also classified as unavoidable (see also SI, Section 4.19).

This definition of *food losses* differs from that in Gustavsson et al. (2011) by including the *unavoidable losses*, which are omitted in the cited study.

According to Gustavsson et al. (2011), *food waste* is often used for *food losses* occurring at the end of the food value chain (retail and final consumption), where most losses are caused by wasteful behaviour. Nevertheless, in this paper both terms are used synonymously and refer to all *food losses*, because a distinction between wasteful behaviour and other reasons for *food losses* was difficult to perform.

The *food value chain* is the system of organizations, people, and activities involved in moving food from its producer (usually the farmer) to the consumer. In the present work, it also comprises the consumption phase itself and losses that occur at the end consumer.

For the present study, a multitude of data sources was used. Background information about these sources, data quality and calculations is provided in the electronic supplement information, referenced as "SI" (http://dx.doi.org/10.1016/j.wasman.2012.11.007).

2.2. Data acquisition

Table 1 contains an overview of the numbers and types of organisations that provided data about food losses. In order to model the whole food value chain, several data gaps had to be filled with data from the literature and with additional assumptions (details in the Supplement information (SI), Chapters 1 and 4).

2.3. Food categories

In this paper 22 food categories are analysed (Table 2). The categories were defined according to their importance for the Swiss consumer basket and characteristics regarding food losses. For example, berries were defined as separate category because of their high perishability, although they only contribute 0.2% of the calories of total food consumption. In order to avoid double counting of ingredients, the food categories were defined at the level of ingredients. For example, in the category of breads and pastries only wheat was modelled; the other ingredients like sugar and eggs were attributed to other categories.

2.4. System boundary

The analysis in this paper covers the entire food value chain that is related to Swiss food consumption, from agricultural production to the consumer. Food waste in other countries, resulting from the production of food imported for consumption in Switzerland, was included in the analysis, assuming the loss rates to be equal to production in Switzerland. Food waste resulting from the production of food for export was not included. Agricultural production was defined as potential crop yield in edible quality at the time of harvest in the present farming system, including inedible parts that are separated later in the food value chain (e.g. apple cores, peel-

Table 1
Overview of the number and types of firms, institutions and associations providing data (the number of organizations is shown in parentheses). Details about the individual data providers are given in Table S1 in SI.

FIRMS (31)
Agricultural producers (5)
Food trading and logistics industry (5)
Food processing industry (6)
Food service settings, e.g. restaurants (2; data from 201 settings)
Retailers (4)
Bakeries (5; data from 29 branches)
Food banks (4)
Trade and Producer Associations, e.g. farmers' union (10)
Federal Institutions, e.g. federal statistical office (3)