

Food waste matters - A systematic review of household food waste practices and their policy implications



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ABSTRACT

In recent years, food waste has received growing interest from local, national and European policy-makers, international organisations, NGOs as well as academics from various disciplinary fields. Increasing concerns about food security and environmental impacts, such as resource depletion and greenhouse gas emissions attributed to food waste, have intensified attention to the topic. While food waste occurs in all stages of the food supply chain, private households have been identified as key actors in food waste generation. However, the evidence on why food waste occurs remains scattered. This paper maps the still small but expanding academic territory of consumer food waste by systematically reviewing empirical studies on food waste practices as well as distilling factors that foster and impede the generation of food waste on the household level. Moreover, we briefly discuss the contributions of different social ontologies, more particularly psychology-related approaches and social practice theory. The analysis reveals food waste as a complex and multi-faceted issue that cannot be attributed to single variables; this also calls for a stronger integration of different disciplinary perspectives. Mapping the determinants of waste generation deepens the understanding of household practices and helps design food waste prevention strategies. Finally, we link the identified factors with a set of policy, business, and retailer options.

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1. Introduction

Globally, nearly one third of food produced for human consumption is lost or wasted, equalling a total of 1.3 billion tonnes of food per year (Gustavsson et al., 2011). As the production of food is resource-intensive, food losses and wastes are indirectly accompanied by a broad range of environmental impacts, such as soil erosion, deforestation, water and air pollution, as well as greenhouse gas emissions that occur in the processes of food production, storage, transportation, and waste management (Mourad, 2016). Scenarios for Europe indicate a considerable potential for reducing emissions through the reduction of food waste (Rutten et al., 2013) along the stages of the food production and consumption chain (Schanes et al., 2016).

Due to these growing environmental but also social and economic concerns, food waste is increasingly acknowledged as an

urgent issue among governments, businesses, NGOs, academics, and the general public. In response, there is a mounting evidence base on the quantities of food wasted and the related emissions along the food production-consumption chain (e.g. Beretta et al., 2013; Edjabou et al., 2016). Along the food supply chain, private households represent the largest food-waste faction (BIOIS, 2010). Given the high amounts of food waste occurring on the household level, the prevention of food waste at the final stages of the supply chain is of utmost importance to help prevent further climate change (Parfitt et al., 2010). To be more precise, if food is wasted by households at the end of the supply chain, all (fossil) energy (and greenhouse gas emissions) put into its production, processing, transportation, cooling and preparation was in vain.

There is, however, still a relative paucity of field research on the subject of consumer-generated food waste in the context of private households. Despite a growing number of studies, little is known about the determinants of consumer food waste and the underlying factors that encourage, drive or impede food waste behaviours and practices (Graham-Rowe et al., 2014). A closer look at households brings to light that the issues of food waste and sustainable practices around food are multifaceted (Evans, 2014). Given its complex

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nature, the evidence on drivers of food wastage and barriers to its reduction remains scattered. [Thyberg and Tonjes \(2016\)](#) have provided a literature review of the causes of food waste which concentrates on cultural, political, economic, and geographic drivers, with a particular focus on the US. However, a truly systematic review that covers research from social sciences in particular, and delivers a comprehensive map of the intellectual territory of the main reasons for food wastage occurring on the household level, remains absent.

In this paper, we present a literature review of the existing scholarly discussion on the reasons for consumer food waste in a systematic, transparent, and replicable way. We review and analyse evidence on the factors impeding or promoting consumer food waste, and, based on this analysis, discuss the contributions of psychology-oriented approaches as well as social practice theory. Subsequently, we provide insights into policy approaches as well as business options for tackling the issues raised by such evidence, and make suggestions for future research.

The contributions provided by this systematic literature review are two-fold: first, it helps to identify gaps in scholarly evidence which still need to be filled to further grow the knowledge-base on food waste behaviour; second, it provides a knowledge repertoire and thus guidance for evidence-based management and policy-making which can potentially improve the quality and effectiveness of policy measures as well as technological innovations targeted towards food waste reduction.

2. Method

In this paper, we review the still modest but rapidly growing body of academic literature on consumer food waste. Thereby, we go beyond a sole focus on individual consumers and situate consumer food waste in the context of private households (see also [Wahlen and Winkel, 2016](#)). Empirically, we orient ourselves along the systematic literature review methodology. For practitioners, systematic reviews can help address managerial problems by producing a reliable knowledge base through accumulating findings from a range of studies. For scholars, systematic reviews can enhance methodological rigor as well as highlight opportunities for further research ([Briner and Denyer, 2012](#); [Rousseau et al., 2008](#)).

In our study, we first located relevant studies based on our review objective of distilling evidence on why food waste occurs in households. Here, we limited the search to peer-reviewed journal articles published in English and consciously omitted grey literature such as research reports or books. We believe a highly commendable scientific journal should refer to peer-reviewed literature only. Besides, 'grey' literature that meets scientific standards are often published in the scientific literature in form of a condensed version (e.g. [Quested et al., 2013](#)). Yet, we included important 'grey' literature that provides valuable policy recommendations in the discussion (Section 4).

The databases Web of Science, Scopus, and GoogleScholar were used as a basis for the literature search. The initial key word search included the search strings "food waste" AND "consumer" as well as "food waste" AND "household". Subsequently, the articles generated from the initial search were checked manually (mainly by reading through the abstract). We excluded studies that (i) did not have households and consumers as units of analysis; (ii) did not have a focus on reasons and drivers for food waste on the household level (studies that solely dealt with the quantification of food waste were excluded), and (iii) were not empirical studies (literature reviews were not analysed). This pool of literature was further developed through the snowballing technique i.e. by checking the references of the articles yielded by the initial search. The complete search resulted in a list of 60 articles on which the systematic

literature review is based.

In a next step, we coded the gathered papers on various dimensions using the MAXQDA software tool for qualitative data analysis. The codes are organized around the identified key variables and factors which are sought to impact the amount of food waste occurring in households and that were investigated by the selected studies. The initial codes were scaled up into three core categories: socio-demographic factors, psycho-social factors, and food-related household behaviours. We then identified relations, contradictions and gaps in the literature and discussed them in Section 4. Finally, we synthesized the gathered evidence ([Denyer and Tranfield, 2009](#)) and integrated it into a table that links consumer food waste with its drivers and consequences, as well as connects these drivers and consequences with potential policy, business, and retailer options (see [Table 3](#)).

2.1. Limitations

While this paper has taken a global focus, it draws mainly on empirical studies conducted in Europe. As with any qualitative analysis that brings together studies of households from different geographical locations, the study intends to act as a guide to show tendencies why food waste occurs; however, it does not provide a generalizable truth that is valid for all countries and cultures worldwide. To what extent inconsistencies in results can be explained by country-specific or cultural aspects is outside the scope of this study but could be a potential avenue for further research.

2.2. Analysis of bibliographic information

We provide a succinct analysis of the basic characteristics of the articles selected for the review. [Fig. 1](#) shows the (cumulated) number of empirical, peer-reviewed papers published on food waste from 1980 to early 2017. It is apparent that the academic interest in consumer food waste has steadily increased. The scientific output of food waste-related papers has more than doubled over the course of the last five years.

[Table 1](#) and [Table 2](#) provide an overview of the papers published by author and academic journal respectively. Interestingly, the body of researchers conducting empirical studies on consumer food waste is large and diverse with a total of 154 different authors publishing in 35 different journals. The British Food Journal is the dominant source title followed by Resources, Conservation and Recycling and a variety of journals that published three articles including the Journal of Cleaner Production.

3. Results: Explaining food waste behaviour and practices

In the following sub-sections, we outline and discuss the scholarly evidence on reasons for food waste occurring on the household level. Thereby, we start with a short overview of two social ontologies that have been dominant in the scholarly discussion. After that, we provide insights into individuals' perceptions and understandings of food waste. Furthermore, we present food-related practices and routines in the household that have been found to play a role in the generation of food waste. Finally, we explore the potential role of socio-demographic factors on food waste.

3.1. Theoretical perspectives on food waste

The issue of food waste generation in households of industrialized countries has received attention from scholars of diverse disciplinary fields. While we want to abstain from drawing too

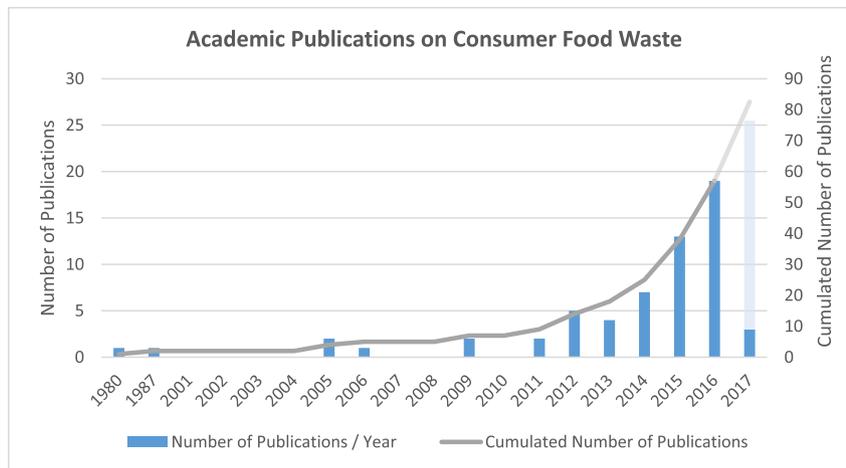


Fig. 1. Academic publications on (consumer) food waste (status: February 15, 2017).

Table 1

Top-24 authors (regardless of authorship) ranked by number of publications on consumer food waste.

Author	Number of Publications	Author	Number of Publications
1 Wansink, Brian	4	13 Hartikainen, Hanna	2
2 Evans, David	3	14 Jessop, Donna C.	2
3 Principato, Ludovica	3	15 Lähteenmäki, Liisa	2
4 Secondi, Luca	3	16 Lanfranchi, Maurizio	2
5 Calabrò, Grazia	2	17 Loebnitz, Natascha	2
6 Cappellini, Benedetta	2	18 Meah, Angela	2
7 De Pascale, Angelina	2	19 Parente, Juracy	2
8 Fazio, Alessandro	2	20 Porpino, Gustavo	2
9 Giannetto, Carlo	2	21 Reinikainen, Anu	2
10 Graham-Rowe, Ella	2	22 Schmidt, Karolin	2
11 Griffith, Christopher J.	2	23 Silvennoinen, Kirsi	2
12 Grunert, Klaus G.	2	24 Sparks, Paul	2

strict disciplinary boundaries, one can broadly distinguish two social ontologies that have enriched the scholarly discussion on consumer food waste. On the one hand, there are psychology-oriented approaches – often rooted in fields of consumer behaviour or environmental psychology – that aim to single-out and measure specific intra-personal, cognitive, motivational and structural factors and processes either driving or impeding pro-environmental behaviour (Steg and Vlek, 2009). In our review, we find that in the field of environmental psychology, the theory of planned behaviour (Ajzen, 1991) is the framework that is

Table 2

Top 12 academic journals ranked by number of publications on consumer food waste.

Academic Journal	Number of Publications
1 British Food Journal	7
2 Resources, Conservation and Recycling	4
3 Appetite	3
4 Food Quality and Preference	3
5 Journal of Cleaner Production	3
6 Journal of Consumer Behaviour	3
7 Journal of Food Products Marketing	3
8 Critical Public Health	2
9 International Journal of Consumer Studies	2
10 PloS one	2
11 The Sociological Review	2
12 Waste Management	2

predominantly applied when investigating food waste behaviour (e.g. Graham-Rowe et al., 2015; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016). According to the theory, individual behaviour is determined by the intention to perform the respective behaviour, and thus, the motivation and willingness to act (Ajzen, 1991). Studies employing this socio-psychological framework provide large-scale findings of a great number of people and establish causal relationships between cognitive as well as socio-demographic variables and actions. For instance, they have provided insights into the role of cognitive processes and determinants of behaviour that are internal to the individual i.e. attitudes, norms, knowledge and intentions.

However, these cognitive and intra-personal factors are only partly able to predict intention and – to a lesser extent – actual behaviour (Gatersleben et al., 2002; Stancu et al., 2016). Studies on food waste have indicated that a higher intention to reduce food waste is significantly (Graham-Rowe et al., 2015; Visschers et al., 2016), or somewhat (Stancu et al., 2016), related to a smaller amount of self-reported food waste. In contrast to these findings, however, a study that included planning and shopping routines as additional factors in the model shows that the intention not to waste food does not have a significant effect on reported food waste (Stefan et al., 2013). In other words, even if people have a high intention to reduce food waste, this volition does often not translate into action. Stefan et al. (2013) explain that by the fact that the creation of food waste is not driven by conscious intentions and that food-related household practices (see Section 3.3) seem to be a better indicator for the amount of food wasted. A common explanation for the weak relationship between the intention to reduce food waste and acting upon it, is the ‘attitude-behaviour’ gap. There is a reported gap between holding environmental attitudes and values, and actually performed environmental behaviour, which has been termed the ‘value-action’ (Blake, 1999) or ‘attitude-behaviour’ gap (Boulstridge and Carrigan, 2000; Vermeir and Verbeke, 2006). Thus, cognitive aspects such as attitudes, intentions and motivations are not (always) a good indicator of less food being wasted. Even though contextual factors such e.g. infrastructure are included as external factors, still they have not been included systematically in applied models (Steg and Vlek, 2009).

In response, more sociological contributions, most notably evolving around social practice theory, have provided an additional, complementary lens on the issue of food waste (e.g. Evans, 2011a, b, 2012a, b; Cappellini, 2009; Cappellini and Parsons, 2012; Ganglbauer et al., 2013; Lazell, 2016; Leray et al., 2016; Meah,

2014; Watson and Meah, 2012). A social practice approach broadens the perspective on food waste generation and allows to move beyond individual psychological factors such as attitudes, behaviour, and choice (see e.g. Shove, 2010 for a critical appraisal). What social practice theory offers is a conceptual approach to grasp the socio-temporal nature of practices unfolding in the household. In doing so, theories of social practice acknowledge the individual as embedded in wider social, economic, and cultural facets of everyday life. Practice approaches therefore omit to frame food waste as problem of individuals. Instead, social practice theories account behaviour to wider factors deemed beyond control of individuals which are reflected in the organization and temporal nature of everyday routines (Evans et al., 2012a, b). The scholarly discussion on food waste has benefited from the application of a practice theoretical lens given the shifting of attention to sequences of daily activities around food in households and the social and material contexts of food practices. Analysing food waste generation from a practice theory approach provides insights into the intersection of various activities, actors, materials, spatial-temporal elements and their implications on the generation of food waste (Southerton and Yates, 2014).

Theories of social practice and models of consumer behaviour are social ontologies which offer different conceptualisations of behaviour and change. Even though radical voices regard an appropriate synthesis of the two perspectives as impossible (Shove, 2010), creating an open and constructive dialogue between these stances is increasingly considered to be desirable among researchers, especially in the area of sustainability (e.g. Piscicelli et al., 2015; Whitmarsh et al., 2011). The present article takes a similar approach and reviews empirical evidence of both psychology and social practice theory to examine how and why food gets wasted. Although we recognize that the underlying conceptualisations between the two positions differ considerably and therefore might not be comparable per se, both strands have contributed significantly to a better understanding of the complex phenomena of food waste.

The following section builds predominantly on studies from psychology-oriented approaches that provide insights into consumer concerns, motivations and norms around food waste and their causal relationship on intention to reduce food waste and (self-reported) behaviour. Beyond that, research along the social practice theory provides a nuanced and sophisticated understanding around meanings and perceptions of food waste. Unlike psychological approaches, social practice theory does not support the assumption of a causal one-way relationship between attitudes or values and practices; instead personal values and practices are regarded as dynamic and co-constructive. More precisely, they interact with one another as personal attitudes or values can be shaped by performing a practice as well as through material and social contexts (Hards, 2011).

3.2. Understandings and perceptions of food waste

Generally, consumers consider throwing away food as improper behaviour (Porpino et al., 2015), and although consumers state that they do not generate (much) food waste, or at least less than others (Graham-Rowe et al., 2014; Neff et al., 2015; Qi and Roe, 2016), the vast majority of households indicate that they are at least somewhat concerned about throwing away food (Abeliotis et al., 2014; Evans, 2011a). Concern about food waste is a significant predictor of food waste reduction (Principato et al., 2015) and plays an important role in the intention to reduce food waste (Mondéjar-Jiménez et al., 2016; Stancu et al., 2016; Stefan et al., 2013). People that voice a high environmental concern have a marked aversion towards wasting food (Melbye et al., 2016). This is reflected in

statements that it is 'wrong or bad' to waste food (Evans, 2011b; Ganglbauer et al., 2013; Graham-Rowe et al., 2014; Quedsted et al., 2013). Some consumers also associate food waste with emotions of 'disgust' (Radzyminska et al., 2016; Waitt and Phillips, 2016; Watson and Meah, 2012), 'hate' (Waitt and Phillips, 2016), 'frustration' or 'annoyance' (Graham-Rowe et al., 2014), and 'anxiety' (Evans, 2011a; Graham-Rowe et al., 2014). In addition, a high sense of guilt about throwing away food is expressed by the majority of households (Ganglbauer et al., 2013; Grandhi and Appaiah Singh, 2016; Parizeau et al., 2015; Pearson et al., 2016; Qi and Roe, 2016; Quedsted et al., 2013; Stefan et al., 2013). Several studies also suggest that guilt in particular may act as an important motivation underlying the reduction of food waste (Neff et al., 2015; Qi and Roe, 2016; Quedsted et al., 2013) as households that voice more guilt about wasting food produce less food waste (Parizeau et al., 2015). Qi and Roe (2016) even argue that reducing food waste could be motivated by installing feelings of guilt, which then act as a moral norm to handle food less wastefully.

3.2.1. Concerns

Generally, personal concerns, such as saving money, elicit a stronger motivation to reduce food waste than environmental and social concerns (Graham-Rowe et al., 2014; Neff et al., 2015; Stancu et al., 2016). Financial concerns associated with the money that is lost when throwing away food are commonly mentioned as the main motivation for minimizing food waste (Graham-Rowe et al., 2014; Neff et al., 2015), both in qualitative (Blichfeldt et al., 2015; Graham-Rowe et al., 2014; Grandhi and Appaiah Singh, 2016) and quantitative research (Neff et al., 2015; Principato et al., 2015; Qi and Roe, 2016; Stancu et al., 2016). For instance, a study from Greece reveals that the main reason for the reported reduction in food waste lies in spending restrictions at the food provision level as a consequence of the recession (Abeliotis et al., 2014). Equally, a qualitative study from the UK stresses that the avoidance of food waste was mainly driven by thrift and a responsible and economical use of resources (Watson and Meah, 2012). Furthermore, wasting food is considered as a waste of the time put into the provision and preparation of food (Neff et al., 2015; Watson and Meah, 2012).

Interestingly, concerns about the environmental impacts of food waste turn out to be a minor motive to reduce wasteful behaviour (Neff et al., 2015). While consumers raise concerns about global warming and the excess use of resources (Tucker and Farrelly, 2015) or express an environmental consciousness through their beliefs and reported behaviours (Parizeau et al., 2015), environmental concerns rank behind other factors when it comes to reducing food waste (Abeliotis et al., 2014; Graham-Rowe et al., 2014; Pearson et al., 2016; Principato et al., 2015; Quedsted et al., 2013; Stefan et al., 2013; Watson and Meah, 2012). Two studies in the U.S. have found a modest role of environmental concerns with only 40% (Neff et al., 2015) and 58.4% (Qi and Roe, 2016) of respondents expressing concerns about the environmental consequences associated with throwing away food. Notably, 22% of respondents stated that environmental concerns were not at all important motivations (Neff et al., 2015). Also, it seems that the degree of environmental concern with regards to food waste correlates with socio-demographic factors such as the level of education (Qi and Roe, 2016) or age. Younger persons, for instance, focus more on the financial dimensions of food waste while older people indicate more concern about its social and environmental consequences (Blichfeldt et al., 2015; Tucker and Farrelly, 2015a). Some studies, however, show that people over 65 actually are less engaged with global environmental issues (e.g. Quedsted et al., 2013).

What could explain the weak role of environmental concerns is a lack of awareness and knowledge about the link between food

waste and ecological impacts (Graham-Rowe et al., 2014; Quedsted et al., 2013; Stefan et al., 2013). For example, Principato et al. (2015) have found that 60% of respondents were strongly convinced that product packaging has a greater environmental impact than food waste. In addition, Watson and Meah (2012) indicate that none of their respondents explicitly raised the link between greenhouse gas emissions and the production of food. Alternatively, consumers may believe their impact to be minimized because of composting food waste or feeding food surplus to their pets (Graham-Rowe et al., 2014; Neff et al., 2015).

3.2.2. Norms and perceived behavioural control

A range of studies have investigated the social and ethical dimension of food waste. For example, Parizeau et al. (2015) highlight that for a majority of respondents food waste is primarily a social issue. In addition, they show that those who regard food waste as a social problem produced less waste. Similarly, Setti et al. (2016) show a high degree of ethical concern related to food waste (86%). Ethical considerations regarding a lack of food in other countries have been noted by a number of authors (Blichfeldt et al., 2015; Ganglbauer et al., 2013; Neff et al., 2015; Pearson et al., 2016). Moreover, there is ample evidence that people are uncomfortable with wasting food due to the perceived value of food itself (Ganglbauer et al., 2013; Graham-Rowe et al., 2014; Watson and Meah, 2012).

The role of norms on the intention and action to reduce food waste has also attracted attention of various scholars. While subjective norms (commonly approved or disapproved behaviours in a culture) seem to have no influence on food waste behaviour per se (Graham-Rowe et al., 2015; Stefan et al., 2013; Visschers et al., 2016), they foster the intention to reduce food waste (Graham-Rowe et al., 2015; Stancu et al., 2016). Personal norms (feeling obliged not to waste food), in contrast, turn out to be a significant direct predictor of the amount of food wasted, implying that if households hold strong personal norms that oppose food waste, they tend to waste less (Visschers et al., 2016). Descriptive norms (an individual's perception of whether social surroundings such as friends, family and neighbours, carry out or avoid certain behaviours), however, are not a significant predictor (Graham-Rowe et al.,

2015). A possible explanation of the weak connection between norms and actual behaviour may be that the amount of food waste occurs not visible to other people so that they cannot be blamed for wasting much.

What turns out to play a crucial role for people's food waste behaviours is perceived behavioural control. Consumers who trust in their ability to reduce their waste and consider reducing food waste under their control, are more likely to reduce food waste directly or at least have a higher intention to do so (Graham-Rowe et al., 2015; Mondéjar-Jiménez et al., 2016; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016).

Looking beyond the individual consumer or household members and related cognitive aspects, the subsequent section situates food waste generation in the broader context of the household, recognizing the understanding that food waste practices are linked with other practices in and around the household.

3.3. Food-related household practices and routines

A growing body of literature has investigated food-related practices and routines in the context of food waste generation. Particularly studies adopting conceptual approaches such as practice theory provide intriguing insights by scrutinizing food waste in relation to daily food-related procedures and processes at the household level (e.g. Wahlen, 2016). Given the complex nature of food waste, household routines (see Fig. 2) such as planning, shopping, storing, cooking, eating, and managing leftovers play a decisive role in food provisioning but also in food waste generation (e.g. Wahlen, 2011, 2016; Evans, 2012). Along all these stages, food items may be assessed with regards to their edibility and consequently either be wasted or re-distributed. Also, various psychological approaches increasingly highlight that routinized household practices such as eating, cooking, and planning (see Section 3) play a key role in food waste generation (e.g. Stefan et al., 2013; Stancu et al., 2016; Visschers et al., 2016).

3.3.1. Planning

Careful planning of grocery shopping is an effective tool to prevent overbuying, and consequently, food waste (Parizeau et al.,

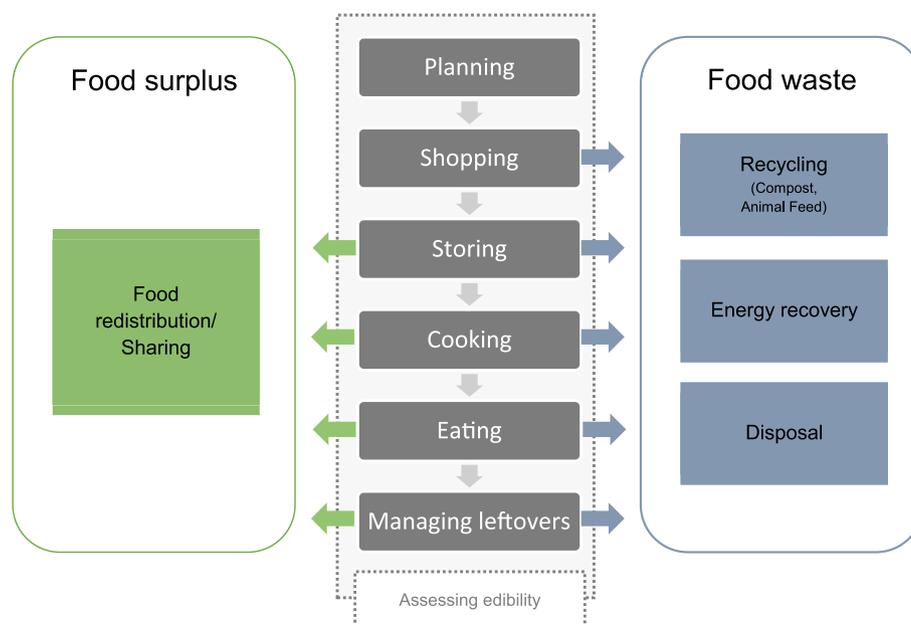


Fig. 2. Food-related practices and routines.

2015; Secondi et al., 2015). Suggested planning strategies encompass writing a shopping list, compiling meal-plans in advance, or checking inventories before shopping. For example, using a shopping list was found to lower the amount of food thrown away per capita by roughly 20% (Jörissen et al., 2015). Farr-Wharton et al. (2014) stress that information about food items stored at home when shopping is crucial to avoid purchasing unnecessary items. Also, communication between household members may help avoid buying the same products twice (Farr-Wharton et al., 2014).

Most people check their food inventory regularly and use a shopping list, whereas more detailed food planning behaviours (such as meal planning and food budgeting) are performed less frequently (Abeliotis et al., 2014; Neff et al., 2015; Parizeau et al., 2015; Rispo et al., 2015; Schmidt, 2016b). Furthermore, consumers who are busy with work and/or leisure time, tend to not look into the fridge prior to shopping, and therefore are more prone to purchase something that is already at home (Ganglbauer et al., 2013).

However, while some studies suggest that meal planning results in less food being wasted (Farr-Wharton et al., 2014; Jörissen et al., 2015; Mallinson et al., 2016; Quested et al., 2013; Stefan et al., 2013), other studies have not found a clear correlation between proper planning and reduced food waste levels (Stancu et al., 2016; Visschers et al., 2016). Nonetheless, stronger planning routines are related to lower reporting of buying unplanned items and big packages (Stancu et al., 2016).

3.3.2. Shopping

Much of the current literature on the drivers of food waste pays particular attention to provisioning and shopping routines. Even though a majority of consumers claim to buy an accurate amount of food (Parizeau et al., 2015), people often follow a routine of buying more food than needed (Evans, 2011a). Overprovisioning of food seems to be one of the most prominent reasons leading to superfluous food (Evans, 2011a; Mallinson et al., 2016; Radzyminska et al., 2016). Identified reasons for overprovisioning include (i) the good provider identity, (ii) differences in taste, (iii) the compensation effect, (iv) time constraints, (v) bulk purchases, and (vi) oversized packaging.

First, the 'good provider identity', which refers to the wish to be a 'good' parent or a 'good' partner, appears to be an important reason for food waste in both qualitative (Evans, 2011a; Graham-Rowe et al., 2014; Porpino et al., 2016) and quantitative (Visschers et al., 2016) studies. This identity is characterized both by the desire to provide an abundance of food as well as the wish to serve food that is perceived to be "proper" (Graham-Rowe et al., 2014); through this, providers express affection and love to their family (Evans, 2011a; Porpino et al., 2016). Usually, food that is healthy and nutritious is considered "proper". Yet, buying healthy food does not necessarily result in its consumption (Evans, 2011a) but to an abundance of perishable foods that are at risk of wastage. Evidence suggests that the good provider identity goes beyond the own household and encompasses guests as well. Being a 'good' host triggers providing an abundance of food for social occasions, as serving not enough or not the right food might be embarrassing (Graham-Rowe et al., 2014). This has been, for example, observed among low-income families in Brazil where having enough food at home is considered a sign of hospitality and wealth (Porpino et al., 2015).

Beyond that, different understandings of 'eating properly' often go along with different tastes among household members which can lead to buying an abundance of food to suit different preferences (Evans, 2011a). Additionally, a 'compensation effect' can occur when people usually eat meals that are perceived as unhealthy, and in order to mitigate guilt they buy an abundance of

healthy and perishable food which in turn is often wasted (Porpino et al., 2016).

Overprovisioning of food is also connected to the perceived availability of time. Stockpiling food for unexpected occasions is seen to reduce stress and save time, but could lead to buying more products than one can consume in a timely manner (Ganglbauer et al., 2013; Graham-Rowe et al., 2014). Additionally, a perceived lack of time may prevent one from cooking planned meals for which ingredients have already been bought (Ganglbauer et al., 2013; Watson and Meah, 2012).

It is widely assumed that promotional offers such as "Buy One, Get One Free" (BOGOF) encourage consumers to buy more than actually needed, and thus promote the wasting of food (Farr-Wharton et al., 2014; Graham-Rowe et al., 2014; Mondéjar-Jiménez et al., 2016; Porpino et al., 2015). Even though consumers state that bulk purchases potentially lead to more food waste (Qi and Roe, 2016), several studies point out that food waste amounts are on average lower in households that are more prone to buy discounted food (Jörissen et al., 2015; Koivupuro et al., 2012) or consider low prices an important factor when buying groceries (Jörissen et al., 2015; Koivupuro et al., 2012; Williams et al., 2012). In turn, households that spend more money on groceries per person tend to produce more food waste per person (Parizeau et al., 2015; Setti et al., 2016).

One of the main reported reasons for wasting food mentioned by consumers is the package size of certain products which is often too large and not suitable for people who live alone or as couples, whereas the prices of not pre-packed foods or smaller packages are comparatively high (Evans, 2011a; Graham-Rowe et al., 2014). Williams et al. (2012) state that up to 20–25% of food waste can be related to too large package sizes and difficult-to-empty packaging.

Alongside overprovision, the role of infrastructures of provision, the type of store where grocery is purchased, and shopping frequency have been investigated. Various studies highlight that food is mainly purchased from major supermarket chains, with some households also purchasing from smaller stores and farmers' markets (Farr-Wharton et al., 2014; Jörissen et al., 2015; Parizeau et al., 2015; Yildirim et al., 2016). Jörissen et al. (2015) show that food waste is highest when people exclusively shop in large supermarkets, and decreases when purchasing takes place in different shopping facilities, in small shops and local markets, and is lowest when people also grow their own food. Moreover, Setti et al. (2016) reveal that consumers who buy local products on a regular basis tend to significantly limit (up to 90%) the frequency of wasting vegetables. Ganglbauer et al. (2013), in their qualitative study in Austria, have observed that self-grown and harvested food is less likely to be thrown away because people are more aware of the time and effort that was put into producing it. Alternative food provisioning schemes, such as community-supported agriculture (CSA) might produce even more food waste because consumers are provided with large amounts of greens and vegetables that they may not like or not know how to prepare (Porpino, 2016).

Shopping frequency also seems to influence the amount of food wasted. Jörissen et al. (2015) show that in Germany food waste slightly decreases with increased shopping frequency, whereas in Italy the opposite has been found. Williams et al. (2012), similarly to the result in Germany, observed less food waste in households that purchase groceries more often. Ultimately, shopping for imperfect food could help to prevent food waste in the upper parts of the supply chain. In general, seemingly imperfect foods that deviate from common standards with regards to appearance or best-before dates are accepted by consumers if their deviation is only moderate (Loebnitz and Grunert, 2015; Loebnitz et al., 2015). However, sub-optimal foods are perceived less positively with regards to taste, freshness, and safety (de Hooge et al., 2017).

3.3.3. Storing

Systematically storing and categorizing food products (e.g. systematic stacking of newer and older foods, or according to frequency of use) in combination with periodic re-ordering can lower food waste generation (Farr-Wharton et al., 2014; Waitt and Phillips, 2016). During processes of ordering and disposal, food items can be re-examined, re-experienced, and re-valued, e.g. to be used for a meal, replaced within the place of storage, or moved out of it (Waitt and Phillips, 2016). Thus, ordering practices can enhance visibility and prevent forgetting food that is hidden in the back of the refrigerator or cupboard. Space constraints in the fridge in combination with a lack of knowledge about where to best locate certain types of foods often hinder systematic storage. Indeed, a majority of consumers fail to use storing strategies to increase food longevity in their households (Farr-Wharton et al., 2014) and have their fridges set to a higher temperature than recommended which can accelerate the decay of food products (Marklinder and Eriksson, 2015; Terpstra et al., 2005).

Another strategy to prevent food going to waste is the freezing of food, thereby extending the shelf-life of food and leftovers (Martindale, 2014; Quested et al., 2013; Secondi et al., 2015). The strategy's actual potential is not fully realised by households yet (Leray et al., 2016). Visschers et al. (2016) have not found a direct relation between knowledge about storage and amount of food wasted. Knowledge about proper storage may, however, have indirect effects on intention and food waste behaviour through other variables, such as personal attitudes and perceived behavioural control.

3.3.4. Cooking

The review of research on the role of cooking practices for food waste has revealed several key aspects. First, often too much food is prepared which ends up being thrown away (Graham-Rowe et al., 2014; Porpino et al., 2015; Silvennoinen et al., 2014). A greater frequency of cooking is likely to enhance cooking skills such as more precise portion control (Graham-Rowe et al., 2014; Jörisen et al., 2015; Mallinson et al., 2016). Indeed, Secondi et al. (2015) have identified a better estimation of portion sizes as one of the most promising actions to avoid wasting food. Second, families with children find it difficult to predict whether their children will be eating at home at all (Cappellini and Parsons, 2012; Evans, 2011a; Ganglbauer et al., 2013; Porpino et al., 2015). Finally, larger plates induce people to eat more and increase the amount of food wasted (Wansink and Van Ittersum, 2013).

An effective waste prevention strategy is cooking based on what is stored at home (Ganglbauer et al., 2013; Graham-Rowe et al., 2014; Watson and Meah, 2012). Relatively fixed repertoire of recipes, where meals are 'tried and tested' and not improvised with ingredients left in the fridge or cupboards, could potentially be a cause of food being wasted (Evans, 2011a, b). A barrier to 'food waste cooking' is that cooking with what is found in the fridge requires time, knowledge and cooking skills to better utilise food creatively; also, family members might not like new recipes (Cappellini and Parsons, 2012; Evans, 2012b; Farr-Wharton et al., 2014). Finally, Mallinson et al. (2016) have found that consumers who mostly rely on convenience food, both ready-made meals and restaurant take-away, waste more edibles than others.

3.3.5. Eating

Only a few studies investigate the role of eating practices for food waste generation. Some studies suggest that especially households with children generate more waste from meals, given the rather unpredictable eating patterns and preferences of children (Cappellini and Parsons, 2012; Evans, 2011a, 2012). The unpredictability of appetite, albeit for different reasons, holds true

also for adults (Ganglbauer et al., 2013). Further, Parizeau et al. (2015) have demonstrated that households members with special diets (e.g. vegetarians) tend to reduce their food waste.

People who spend more money eating out in restaurants report to waste more and express lower levels of guilt for wasting. Interestingly, eating out does not necessarily mean spending less money on groceries. Eating out often is decided spontaneously, so that purchased foods and/or leftovers spoil and are wasted because of more convenient or time-saving options such as going to restaurants (Evans, 2012b; Parizeau et al., 2015). As a result, there seems to be an incongruity between food bought and food actually eaten within a certain time frame. This unpredictability of eating patterns, driven by unexpected dinner invitations or spontaneously spending time with friends, leads to foods remaining uneaten and, in turn, wasted (Evans, 2012; Ganglbauer et al., 2013; Waitt and Phillips, 2016). Furthermore, some respondents experience an inner conflict that revolves around finishing all the food provided on their plate to reduce food waste on the one hand, and avoiding eating too much to maintain a healthy, slim body on the other hand (Hoek et al., 2017; Pearson et al., 2016).

3.3.6. Managing leftovers

Reusing leftovers is considered one of the most effective strategies to combat food waste at the household level (Secondi et al., 2015). Those who regularly eat leftovers produce less food waste (Stancu et al., 2016; Stefan et al., 2013). Yet, even though reusing leftovers is appreciated for its time-, labour-, and money-saving qualities (Cappellini, 2009; Waitt and Phillips, 2016), its realization often faces considerable barriers. Households have problems in assessing the durability of leftovers and therefore tend to be concerned by safety issues when considering them for reuse (Farr-Wharton et al., 2014). People who have a lower risk perception when consuming leftovers (of getting poisoned by food), throw away less food (Principato et al., 2015; Visschers et al., 2016). Also, eating leftovers is frequently associated with feelings of sacrifice and thrift for the good of the family (Cappellini, 2009; Cappellini and Parsons, 2012). Serving leftovers to children is sometimes accompanied with a sense of guilt for not caring properly for them (Cecere et al., 2014). Beyond that, people often find it boring to eat the same meal repeatedly (Cappellini, 2009) or have an aversion to reheating leftovers, because those are perceived to offer less quality and freshness. Using parts of the old dish and make a completely new one out of it often requires too much time and efforts (Cappellini and Parsons, 2012).

When stored, leftovers are often misplaced, forgotten and/or stored for too long in the fridge and therefore expire more frequently (Blichfeldt et al., 2015; Farr-Wharton et al., 2014; Waitt and Phillips, 2016). In line with that, more attention has recently been paid to the notion of 'procrastination' (Blichfeldt et al., 2015; Evans, 2012b; Waitt and Phillips, 2016), i.e. postponing the unpleasant experience of throwing away leftovers until they are sufficiently spoiled and finally must be discarded (Waitt and Phillips, 2016). People usually feel less guilty about binning food that has gone bad compared to food that may still be edible or simply has aesthetic flaws. Finally, serving leftovers is less acceptable when guests are invited for a meal as it is important to present the family in the best possible light (Cappellini, 2009; Cappellini and Parsons, 2012).

3.3.7. Assessing edibility

The ways in which the edibility of food is assessed varies profoundly across consumers (Blichfeldt et al., 2015). Commonly, people use multiple strategies for assessing the edibility of their food (Parizeau et al., 2015), such as smelling or tasting as well as checking whether the "best before" date has passed. A less common

strategy is to track how long food items have been opened or stored (Neff et al., 2015; Parizeau et al., 2015). Respondents who use to discard food after it has been stored in the refrigerator for several days tend to produce more overall food waste than others. By contrast, fewer waste is produced in households that infrequently throw away food that has passed its best before date. In other words people who use more nuanced assessments of food edibility (using own senses) are wasting less food (Parizeau et al., 2015). However, if respondents use many different criteria to assess edibility out of fear of possible food risks, they throw away more food (Parizeau et al., 2015; Van Garde and Woodburn, 1987). Williams et al. (2012) indicate that respondents with greater environmental commitment waste less food that has passed its 'best before date'. The reason may be that they make more use of their sensory skills and/or are more prone to eating 'expired' food.

Various studies highlight that people experience a conflict between trying to avoid food waste and protecting themselves from food-related health risks (Blichfeldt et al., 2015; Evans, 2011a). Here, concerns about food safety tend to outweigh others, such as wasting food (Graham-Rowe et al., 2014; Meah, 2014; Waitt and Phillips, 2016). Indeed, concerns about foodborne illnesses, together with a desire to eat fresh food, are prominent reasons for discarding food (Lanfranchi et al., 2016; Neff et al., 2015; Qi and Roe, 2016). People who think that it is better to throw away leftovers than to risk eating unsafe food are less likely to reduce food waste (Principato et al., 2015).

Generally, there is much confusion about different kinds of labels (Abeliotis et al., 2014; Hall-Phillips and Shah, 2017; Yildirim et al., 2016) which may cause people to interpret any date label as a 'use by date', and therefore throw away all food items that 'have expired' although they are actually still safe to eat (Melbye et al., 2016; Silvennoinen et al., 2014). In contrast, Visschers et al. (2016), have not found a correlation between enhanced knowledge about date labels and the amount of food wasted.

3.3.8. Disposal/redistribution

The way in which food is disposed of also influences the amount of food wasted. Considerable amounts of food waste are given to pets (Wenlock et al., 1980). A focus on disposal practices, such as recycling or composting, often undermines people's motivation for waste prevention (Cecere et al., 2014; Tucker and Farrelly, 2015). For instance, people consider the food that is fed to animals or composted not as waste (Neff et al., 2015; Pearson et al., 2016; Porpino et al., 2015). Recycling may even induce an increase in waste production by mitigating the guilt associated with wasteful consumption (Catlin and Wang, 2012).

The evidence base on the recirculation and redistribution of surplus food is scarce. While gifting among close family members is not unusual, giving cooked food to others seems to be a more uncommon practice, possibly because people do not want to expose their culinary competence to strangers as the food could be perceived as 'bad' (e.g. not sophisticated, tasting poorly, or consisting of low-quality ingredients) or it could make people ill (Evans, 2012b; Lazell, 2016).

3.4. Socio-demographic characteristics

While one would expect that socio-demographic factors provide (at least some) predictive power with regards to the generation of food waste, the empirical evidence is far from clear. Instead, it is hardly possible to single out any socio-demographic factor(s) as explanatory variable(s) for food waste generation. Some studies, however, suggest that a combination of different socio-demographic factors may indicate the amount of food wasted in households (Quested et al., 2013).

There is, for example, no consensus about how far food waste generation is subject to age. While most studies report a negative correlation between the amount of food wasted and age (Secondi et al., 2015; Stancu et al., 2016; Van Garde and Woodburn, 1987; Visschers et al., 2016), others indicate that older people waste more (Cecere et al., 2014). However, generally, people over 65 years of age tend to waste less food (Quested et al., 2013), which is commonly explained by different attitudes towards food and frugality as well as a greater knowledge of the impacts of food waste compared to younger individuals (Qi and Roe, 2016). The evidence is also mixed when it comes to gender: while some studies report that women produce less food waste (Cecere et al., 2014; Secondi et al., 2015), others indicate that gender does not have a significant effect (Principato et al., 2015), that females waste more (Visschers et al., 2016), or that if a woman is responsible for grocery shopping in the household, more food is wasted (Koivupuro et al., 2012; Silvennoinen et al., 2014).

While there seems to be no strong correlation between education level and food waste (Cecere et al., 2014; Neff et al., 2015), some studies indicate that employment status is potentially associated with food waste generation, i.e. that employed people tend to produce more food waste (Cecere et al., 2014) compared to individuals not in the labour force (Secondi et al., 2015). Also, people who are full-time employed commonly feel that they have less time to worry about food waste (Qi and Roe, 2016). Temporal constraints due to high workload are also identified as drivers for food waste (Jörissen et al., 2015). Thus, full-time employment could have a negative effect on the amount of food wasted. Some studies find a positive correlation between income and food waste (Ganglbauer et al., 2013; Stancu et al., 2016) or report that households with different income levels differ in particular with regards to their attitudes towards food waste reduction (Principato et al., 2015; Qi and Roe, 2016) as well as with regards to which type of food is wasted (Setti et al., 2016). Other studies, however, find no correlation between income and food waste (Koivupuro et al., 2012; Visschers et al., 2016; Wenlock et al., 1980) or income and food waste attitudes (Melbye et al., 2016).

Smaller households produce less waste than larger ones while the amount of food waste generated per capita decreases with increasing household size (Jörissen et al., 2015; Koivupuro et al., 2012; Parizeau et al., 2015; Quested et al., 2013; Silvennoinen et al., 2014; Stancu et al., 2016; Tucker and Farrelly, 2015; Visschers et al., 2016; Wenlock et al., 1980). Households with children tend to produce more food waste (Parizeau et al., 2015; Visschers et al., 2016), potentially because of time and money constraints (Parizeau et al., 2015), parents paying high attention to food quality (Terpstra et al., 2005), feeling less knowledgeable about how to avoid food waste (Neff et al., 2015), or due to unpredictable eating behaviour and food preferences of children (Jörissen et al., 2015; Neff et al., 2015). Single households are wasting the most on a per capita basis (Jörissen et al., 2015; Koivupuro et al., 2012; Silvennoinen et al., 2014) which is linked to the lifestyles of single persons (Ganglbauer et al., 2013). Also, studies report that individuals living in urban areas produce more food waste (Cecere et al., 2014; Secondi et al., 2015); others find no significant relationship between urban residence and self-reported food waste behaviour (Neff et al., 2015).

4. Discussion: key leverage points for household food waste prevention

In order to meet the Sustainable Development Goals (SDG 12), including the target to halve per-capita food waste at the consumer level by 2030, a multifaceted approach and a combination of measures is essential. Despite the growing attention on food waste

on the policy level, current approaches mainly concentrate on awareness raising and information provision in order to correct information deficiencies, modify attitudes, or eliminate barriers on an individual level (Evans et al., 2012a, b). Yet, a coherent and holistic policy framework that triggers appropriate action beyond the individual level and empowers actors along the supply chain is missing. In the subsequent section, we discuss a set of policy measures, possible actions for producers and retailers as well as mobile applications that could help to reduce food waste on the household level. Table 3 provides an overview of food waste prevention mechanisms that are described briefly in this section and which were developed based on factors and practices that drive wastage outlined in Section 3.

4.1. Policy initiatives

4.1.1. Economic instruments

Economic incentives aim to reduce food waste through costs or other market signals (Driesen, 2006; FUSIONS, 2016). They can be categorized into fees, taxes, and subsidies. Financial instruments are considered a powerful tool to shift consumption patterns towards more sustainable food practices (Reisch et al., 2013). It is assumed that if the real cost of natural resource use is reflected in prices, consumers are more likely to become active in food waste prevention (UNEP, 2014). The volume- or weight-based fee system “Pay-As-You-Throw” (PAYT) is a common approach that has been implemented in different countries, such as the United States, Sweden, Canada, Japan, Taiwan, Korea, Thailand, Vietnam and China (UNEP, 2014). In these countries, charging households for personally generated waste has been found to be an effective scheme to reduce food waste (Chalak et al., 2016; Dahlén and Lagerkvist, 2010; EEA, 2009). Currently, however, far too little is known about the effectiveness of taxes and fees. Beyond, taxes and fees, subsidizing workplace canteens or school lunches might help to shift the main meal outside of the home and consequently release some time pressure and reduce the routine of buying too much (Evans, 2014).

4.1.2. Regulations

Regulatory approaches, including waste reduction targets such as laws and standards, mandatory management plans, restrictions or covenants, aim to induce waste reduction and prevention behaviour through penalties for actors who do not comply with regulatory provisions. So far, regulations have been adopted in various countries, such as France, Italy, Belgium and the Netherlands. The National Pact against Food Waste in France, for instance, outlines eleven measures to achieve a food waste reduction of 50% by 2025 (Mourad, 2015). One potential regulatory instrument is the review and elimination of unnecessary food-safety standards that lead to high food waste rates. In comparison to fiscal and economic incentives, well-defined regulations seem to be a more effective tool to combat household food waste generation (Chalak et al., 2016).

4.1.3. Information and education campaigns

Information campaigns present one of the most widespread tools used for food waste prevention and reduction (Priefer et al., 2016). Information and education campaigns, information platforms and face-to-face door-stepping campaigns have been implemented all over Europe to improve consumer's knowledge and raise awareness about food waste prevention.

Concrete, current examples are the “Stop Food Waste Programme” in Ireland, “Lebensmittel sind kostbar!” in Austria, or “Think.Eat.Save Reduce your Foodprint” in Europe. The British “Love Food Hate Waste” campaign is by far the most successful food

waste awareness campaign in Europe. Operated by WRAP and sponsored by governments across the UK and Europe, the campaign claims to have helped preventing 137,000 tons of food waste since 2007 (e.g. WRAP, 2012a). Finally, door-stepping campaigns that focus on face-to-face contact with residents may lead to meaningful behavioural changes (Fahy and Davies, 2007; Farrelly and Tucker, 2014; Rispo et al., 2015).

In order to be effective, information initiatives have to specifically address the specific knowledge gaps that drive wasteful practices. With regards to food storing, for instance, there is a need to assist consumers in building knowledge and skills around systematic food storage practices and freezing strategies (WRAP, 2012b, 2017). Moreover, it is crucial to provide information on the shelf-life of fresh food and leftovers (Farr-Wharton et al., 2014; Jörissen et al., 2015). Waste cooking courses can help households to reduce food waste and make their cooking repertoire more flexible (Mondéjar-Jiménez et al., 2016). Education on the meaning of date labelling (Newsome et al., 2014) combined with efforts to increase the acceptability of imperfect food (e.g. food that is less fresh, less aesthetically attractive, or nearing its expiration date) will also be a key component in counteracting confusion among households (Neff et al., 2015).

Schmidt (2016a) points out in her intervention study that it is crucial to personalize information on waste-preventing behaviours for respective target groups rather than providing general lists of all possible measures. With regards to information channels, Qi and Roe (2016) as well as Tucker and Farrelly (2015) show that leaflets, word of mouth, and television shows or movies are especially effective ways to deliver information. In contrast, Principato et al. (2015) find a significant relationship between reduced food waste and information provided both online and in traditional newspapers. Finally, interventions that place a household's food waste level in relation to societal averages or a socially-endorsed goal (benchmarking) result in stronger norm activation (Porpino et al., 2016).

4.2. Business and retailer solutions

4.2.1. Packaging

The nature of packaging, its size and its labelling affect the lifespan of food (Priefer et al., 2016; Quedsted et al., 2013; Wikström et al., 2014). To extend the lifespan of food, intelligent packaging innovation and new technologies with improved protection, communication, convenience, and containment are slowly entering the market (Vanderroost et al., 2014). Various technologies aim at extending the shelf-life of food, such as Multilayer Barrier Packaging and Modified Atmosphere Packaging (Verghese et al., 2015). The most prominent technology - the Modified Atmosphere Packaging - alters the atmosphere inside the package by a natural interaction between the respiration rate of the product and the transfer of gases through the packaging material (Oliveira et al., 2015). Various consumer studies indicate that re-sealable, easier-to-empty packages, and a greater variety of product sizes can reduce food losses (e.g. Verghese et al., 2015; WRAP, 2017; Williams et al., 2012). Financial incentives could probably encourage food producers to establish enhanced packaging solutions. Finally, less packaging on perishable food could allow consumers to pick exactly the amount of food they require and thus avoid over-buying. Evans (2014) suggests to provide fresh, mixed vegetables in pre-made packages to aid the preparation of certain dishes.

4.2.2. Date-labelling

Date-labelling on packages is a key instrument of food policy, situated between production, retailing and consumption (Milne, 2012). As already indicated in Section 3, a lack of knowledge

Table 3

Underlying reasons for food waste in households and possible prevention measures.

Underlying reasons for food waste	Measures to reduce and prevent food waste
Understandings and perceptions of food waste	
Lack of awareness about the amount of food wasted	<ul style="list-style-type: none"> - Measures around social proof i.e. measuring a household's food waste level and placing it in perspective of societal averages or a socially-endorsed goal (P) - Taxes and fees such as PAY schemes on food waste and mandatory separate collection (P) - Door stepping campaigns, HomeLabs, Peer-supported processes, Action research (P, R) - Improved availability of food waste data (R&D)
Insufficient concern about food waste	<ul style="list-style-type: none"> - Information campaigns on why food waste is an environmental, economic, and social problem (P)
Missing link between food waste and environmental consequences	<ul style="list-style-type: none"> - Regulations (waste reduction targets, laws and standards, mandatory management plans) (P)
Lack of trust in one's ability to reduce household waste (lack of perceived behavioural control)	<ul style="list-style-type: none"> - Educational programs and campaigns aimed at promoting volitional control (P)
Acceptance of wasting food as a social norm	<ul style="list-style-type: none"> - Communication campaigns focused on strengthening the belief that wasting foods is bad, unnecessary and immoral (P)
Food-Related household practices and routines	
Planning	
Lack of planning of food shopping and meals	<ul style="list-style-type: none"> - Information campaigns on planning e.g. shopping lists and meal plans (P)
Lack of control on food supply and location at home	<ul style="list-style-type: none"> - Smart fridges (B, R&D)
Inadequate communication between household members	<ul style="list-style-type: none"> - Mobile applications that list food inventory (B)
Shopping	
Good provider identity	<ul style="list-style-type: none"> - Pre-made packages of mixed vegetables (B)
Differences in taste	n/a
Compensation effect	
Time constraints	<ul style="list-style-type: none"> - Subsidized workplace canteens or school lunches (P)
Oversized packaging	<ul style="list-style-type: none"> - Provision of different package sizes (B) - Less packaging on perishable food (B, R)
Shopping routines focused on major supermarket chains	<ul style="list-style-type: none"> - Shopping in smaller shops, farmers markets, grow own food (H)
Preference for fresh food/	<ul style="list-style-type: none"> - Education efforts to foster the acceptability of foods that are older and/or less aesthetically pleasing, or nearing their expiration dates (P)
Lack of acceptance of imperfect food	<ul style="list-style-type: none"> - Revision of food product standards (P) - Supply of sub-optimal foods at a discount (R)
Storage	
Improper and unsystematic storage practices	<ul style="list-style-type: none"> - Smart fridges & innovative domestic refrigerator designs (B, R&D) - Improved temperature control in fridges (B) - Improved packaging (re-sealable, prolonging shelf-life of food) and specific storage guidelines (B, R&D) - Information campaigns and training offers on food storage and freezing (P) - Having a pantry or outdoor earth cellar to store food (H)
Cooking	
Over-preparation of food (e.g. portion control)	<ul style="list-style-type: none"> - Training of cooking skills and using kitchen devices for better portion control (H)
Lack of knowledge and skills for cooking with leftovers	<ul style="list-style-type: none"> - Provision of mobile applications, platforms, books and courses on waste cooking (P, B)
Fixed repertoire of recipes and menus	
Preference of convenience food	<ul style="list-style-type: none"> - n/a
Eating	
Unpredictable eating patterns/ Complexity of daily life	n/a
Eating-out in restaurants	
Large plate sizes	<ul style="list-style-type: none"> - Serving food on smaller plates (H)
Managing Leftovers	
Eating leftovers is perceived as sacrifice, thrift	<ul style="list-style-type: none"> - Sharing food and leftovers (H)
Wish for variety in meals	
Lack of knowledge about leftovers' edibility	<ul style="list-style-type: none"> - Education and information campaigns on: (P) <ul style="list-style-type: none"> ■ the durability of leftovers ■ how to improve visibility in fridge
Procrastination	
Assessing edibility	
Confusion about date labels	<ul style="list-style-type: none"> - Streamlining and optimising of food date labelling (B, P) <ul style="list-style-type: none"> ■ Using consistent date types within product categories ■ Redesigning labels for easier interpretation ■ Enhancing existing storage guidance ■ Lengthening "once opened, use within x days" guidance ■ Adding explanatory text to the snowflake logo
Lack of knowledge about shelf-life of food and how to extend it	<ul style="list-style-type: none"> - Replacement of the 'Freeze on the day of purchase' instruction with 'Freeze by date mark shown' or 'Freeze as soon as possible' (depending on the product)
Concerns about foodborne illnesses and food safety	<ul style="list-style-type: none"> - Adaption of health guidelines (P) - Review of existing food-safety standards(P) - Education and information on campaigns: (P) <ul style="list-style-type: none"> ■ the meaning of different food labels ■ the durability of food products ■ food safety and hygiene
Disposal	
Justification of food waste due to composting, feeding pets, recycling	<ul style="list-style-type: none"> - Information efforts around the food waste hierarchy (P)
Lack of social acceptance of food sharing	<ul style="list-style-type: none"> - Promotion of and financial support for food redistribution programmes (P)

B: Business, H: Households, P: Policy, R&D: Research & Development.

about the meanings of date-labels and confusion around the difference between the expiry date and the date of minimum durability (Regulation 1169/2001/EU) is a major contributor to avoidable consumer food waste (Ceuppens et al., 2016; Newsome et al., 2014; Priefer et al., 2016). To prevent confusion among consumers about expiry dates, a big potential for reducing food waste lies in optimising labels for pre-packed food products (e.g. WRAP, 2011, 2015). More specifically, food waste could be reduced by removing the sell-by date (or date labels completely) from some product groups and extending the list of food products exempted from indicating the date of minimum durability. This may alleviate the perceived trade-off between food waste and foodborne illness (Newsome et al., 2014; Qi and Roe, 2016). Also, technological innovations in labelling may help reduce consumer food waste. So-called Time-Temperature-Indicator (TTI) devices, for instance, show a measurable time-temperature dependent change, reflecting all (or part of) a food product's temperature history. By changing its colour based on temperature and the time elapsed since packaging, low quality and potentially unsafe food can be identified (Newsome et al., 2014; Priefer et al., 2013).

4.2.3. Retailer options

Retailers can support the reduction of food waste by avoiding bulk purchases or by selling less aesthetic foods at discounts (Porpino et al., 2015; Verghese et al., 2015). Further, an investigation of retailer campaigns shows that information by retailers via social media or e-newsletter can reduce self-reported food waste of consumers (Young et al., 2017). Various retailers have already started initiatives to trigger less wasteful consumer behaviour (Young et al., 2017). In 2010, Sainsbury's and Tesco launched the "Buy One Get One Later" (BOGOL) campaign after 2 × 1 promotions (known as BOGOF) were identified as a key reason for over-provisioning of food. In Germany, the supermarket EDEKA launched its "We Love Food" campaign in 2012 that involved the cooking of expired food and damaged fruits and vegetables into jams and jellies. The Morrisons supermarket in the UK uses "best kept" stickers on fresh products to show customers the best way of preserving fresh products at home. Finally, the French supermarket Intermarché and the German REWE Group have started to sell imperfect fruits and vegetables at a discount.

4.3. Mobile applications

The use of technology to support behaviour change is increasingly identified as a key tool to help reduce food waste. Mobile applications such as the German app "Zu Gut für die Tonne" and the British app "Love your Leftovers" provide households with practical advice around extending shelf-life and trying recipes with leftovers. Other applications seek to foster knowledge about food supply and assist users in managing their groceries and planning their meals (Farr-Wharton et al., 2014).

Another strategies revolves around re-distributing surplus food that is still fit for human consumption through online platforms and apps (Davies, 2016). The British app "OLIO", for instance, connects neighbours and local businesses for food sharing. Sharing initiatives are widely spread across Europe, such as the German and Austrian "Foodsharing" or "Slow Food" initiative, the Italian "Next Door Help" and the Spanish "Yo No Desperdicio". However, receiving food from food donors via smart phone applications is not straightforward. Consumers report a range of concerns related to the safety of shared food and a lack trust in the donator (Lazell, 2016). The sharing of food is thus still not a widely socially accepted practice of food provisioning. Beyond this, first

community-based systems that give feedback on individuals' in-home food availability and food waste types and amounts, have been designed and might be relevant for effective food waste prevention (Lim et al., 2017).

5. Conclusion

The present paper set out to review empirical, peer-reviewed studies on households' food waste practices, and distil socio-demographic and psycho-social factors as well as food-related household practices. Overall, we see that research in the field of households' consumer food waste occurring in households is progressing well, evidenced by the growing number of studies. As highlighted by various authors, food waste generation on the household level is a highly complex and multifaceted issue driven by a variety of reasons and types of behaviour. To begin with, our analysis has shown that households are generally concerned and feel guilty about wasting food. These feelings of guilt are mainly based on personal concerns such as financial loss, rather than on concerns about the environmental and social implications of food waste. Several studies have demonstrated that guilt, perceived behavioural control, and negative attitudes towards food waste may predict the intention to reduce food waste and/or reported food waste.

Also, it is noticeable that households often have ambivalent attitudes towards waste prevention and face conflicts between good intentions to reduce food waste and personal preferences regarding food safety, taste and freshness. In addition, reducing food waste may be at odds with the desire to be an organized and careful homemaker, provider, and host. Consequently, people sense a discord between the care for oneself (and immediate others) and eliminating food waste in which they are negotiating a range of contradictory desires, aims and anxieties.

Socio-demographic factors play less of a predictive role, albeit research has found that people over 65 years tend to waste less, and households with children tend to waste more food. On a per capita basis larger households waste less while single households waste most. Overprovision, unsystematic storage, misinformation about the shelf-life of food and date-labels as well as an aversion towards eating leftovers are, among others, prominent reasons for the disposal of superfluous food. Moreover, our analysis shows that the lack of knowledge regarding the social and environmental consequences of food waste needs to be tackled to improve people's awareness of the wider impacts of wasteful behaviour.

While emphasizing the strategies that can be adopted by individuals to prevent food waste in their households, one must however, acknowledge the individual as embedded in wider social, economic, and cultural structures that may prevent the adoption of less wasteful practices. Infrastructure such as storage (e.g. cellar, fridges) and shopping facilities (big supermarkets, local stores, farmers markets) play a decisive role in shaping household food (waste) practices. Furthermore, insufficient time to care about food in general, and food waste in particular, paired with the perceived unpredictability of daily lives may turn food waste prevention into a daunting task. Indeed, a perceived time shortage due to today's complex scheduling of work, family and leisure time appeared at all stages of food-related household practices as a key constraint to practices of food waste reduction such as planning shopping trips, shopping more frequently, shopping at smaller stores, growing one's own food, storing food properly or cooking with leftovers. Yet, there has been little research conducted on how perceived time availability influences people's waste practices. If we are to tackle food waste in a systematic way, we must also take into account the

links between changing patterns of work and leisure (e.g. shorter working hours) and consumer food waste.

Thus, a holistic food waste prevention approach has to go beyond putting the responsibility solely on individuals. In the search for solutions, more aware and capable consumers are needed as much as committed policy makers who are willing to implement the right mix of policy measures to make waste prevention the preferred option for households. The creation of favourable framework conditions as well as the support and cooperation with stakeholders along the supply chain are of utmost importance for a more sustainable and appreciative handling of food. The increasing development and uptake of initiatives around the globe give encouraging signs that tackling food waste features on the political agenda. Yet, awareness raising is still the dominant policy option deployed on a regional, national and European level. Although more information on the shelf-life of food and better storage possibilities is favourable initiatives and measures that engage the public and aim to reconfigure food practices require a multi-tiered approach that combines regulatory frames, infrastructural measures, informational and educational support, price-based measures along with technological and social innovations in consistent and coherent ways. Hence, policy interventions must go beyond individualizing the problem and instead take a proactive approach that tackles practices of all stakeholders along the supply chain in order to push food waste prevention from a systemic perspective. It will require a strategy that coordinates approaches across actors - from the production to the consumption stages - because food getting wasted in households may already be provoked by upstream actors in the food chain (e.g. through incomprehensible date labels, too large or not re-sealable packaging, retailer and sales strategies such as bulk packages, special offers, etc.) which are therefore outside the scope of individual action. Our results suggest, that a starting point for policy makers should be the streamlining and optimising of expire date labels for pre-packed food products, for instance by removing the sell-by date or by removing date labels completely from some product groups and extending the list of food products exempted from indicating the date of minimum durability. However, other underlying reasons for food waste such as the complexity of daily life or the desire to be a good provider, will be much more challenging to address and require more innovative approaches that go beyond traditional policy instruments.

This paper also highlights various areas for further research. From a scholarly perspective, studies employing more objective techniques for data collection, such as trash sorting or kitchen diaries instead of self-reported mechanisms (which can bias individuals towards underestimating their food waste and potentially limit the comparison with other variables) are needed. Moreover, given the multifaceted and complex character of the issue, what is key is a strong collaboration and integration of different disciplinary perspectives. We make a strong plea for research that goes beyond investigating attitudes towards food waste and instead adopt a social practice ontology that potentially sheds light on the daily routines and practice that underlie household food waste. Using multiple methods of data collection (e.g. combining interviews with observations) is important to capture lived experiences and provide a nuanced account of how and why food gets wasted. Furthermore, further research should investigate the role of structural elements such as shopping infrastructures or storage places at home on food waste. Another relevant area of future research concerns the potential of emergent technologies (e.g. smart fridges, fridges and boxes that prolong the shelf life, apps on in-home food availability, etc.) to support food waste reduction. Besides that, there is abundant room to further investigate food sharing practices. Finally, further work is required that tests and

assesses the effectiveness and impact of different policy measures and other interventions on food waste practices.

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