Case Study About Food Losses in German Household

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Introduction

Annually, 6.7 million tons of food go to waste, equal to about one third of all food purchased, a majority of which would have been suitable for human consumption (WRAP, 2008). But food production and food losses are connected with numerous environmental damages and also with rising costs for the food industry and households. According to Grizetti et al. (2013), globally 6.3 Tg of nitrogen arise per year due to food wastage, whereby 2.7 Tg of nitrogen per year occur at the consumer level. In the EU-27 0.4 Tg of nitrogen is discarded per year through food wastage. Food production is responsible for 5.6 Tg of nitrogen per year in the EU-27. Given the fact that 35 % of the nitrogen emissions enter the atmosphere and 65 % goes into water, 12 % of emissions ending up in the water come from wasted food. In total, 0.4 Tg of nitrogen per year are emitted into the atmosphere due to food wastage, whereof 20 % are in the form of greenhouse gases (ibid). In total, the carbon footprint of food losses is estimated to 3.3 Gtons of CO_2 equivalent (FAO, 2013). In Germany each individual causes greenhouse gas emissions in form of 2,500 kg CO_2 equivalent due to his or her nutrition (Noleppa, 2014). Per capita 23 % of German greenhouse gas emissions stem from food consumption and losses (Eberle & Fels, 2014).

Further, the production of food losses is connected to the usage of a variety of resources, for example, 24 % of total freshwater resources (Kummu et al., 2012) and the usage of 1.4 billion hectares of land (FAO, 2013). In Germany, 4 million hectares of arable land and rural land could be saved through individuals making healthier nutritional choices and managing food more efficiently (Noleppa & von Witzke, 2012). In so doing, annually 67 million tons CO_2 equivalent could be avoided, which equals about 800 kg per person (Noleppa, 2014). The largest amount of inserted resources (per capita) for food losses arise in North Africa and West-Central-Asia. The smallest resource use per capita for food losses occur in Saharan Africa and Industrialised Asia (Kummu et al., 2012). In South Africa, the costs of food losses are estimated at 5.2 billion EUR along the whole supply chain. This equals 2.1 % of South Africa's annual gross domestic product. Most of these costs arise both during distribution and processing/packaging and in the sectors of meat and fruit and vegetables (Nahman & De Lange, 2013).

By contrast, in Australian households food is wasted with a value of 3.5 billion EUR every year. On an average, each household cause costs of 418 EUR per year due to wasting food or 162 EUR per person. The highest amount is wasted by fruit and vegetables

(0.75 billion EUR), followed by restaurant and take away (0.71 billion EUR) and meat and fish (0.59 billion EUR) (Baker et al., 2009). In the United States, food losses at retail and consumer level were estimated in 2008 at 112 billion EUR, whereby the highest values come from meat, poultry and fish products (46 billion EUR), vegetables (19 billion EUR) and dairy products (15 billion EUR). The amount of food losses corresponds to 10 % of the annual average food expenditures by consumers. The quantity of food which is purchased but not consumed is estimated at 297 kg per household, equalling a value of 636 EUR per household or 1.74 EUR per household and per day (Buzby & Hyman, 2012). With respect to the UK, WRAP (2008) estimates that consumers pay 14.9 billion EUR for food that is not eaten. The highest costs arise for meat and fish products that are bought and not eaten. Therefore, consumers pay 880 million EUR per year (ibid). In total, 8.3 million tons of food are discarded annually in UK households, which constitutes 3 % of greenhouse gas emissions in the UK (Quested et al., 2011). Altogether, 48 % of calories produced get lost along the supply chain, and approximately half of these losses could have been avoided (Beretta et al., 2013). In developing countries, food losses are higher at post-harvest stages but also for perishable food both in industrialised and developing countries. Overall, most food is discarded at the consumer level (Parfitt et al., 2010). By that food is wasted in households mainly in the time periods between getting home and food preparation, between food preparation and serving or after serving food (Pekcan et al., 2006).

Consumer behaviour related to food losses in households

The highest amount of food losses along the supply chain occur at consumer level (Monier et al., 2010; Parfitt et al., 2010; Gustavsson et al., 2011; Kranert et al., 2012). In the EU-27, consumers are responsible for 42 % of food losses, amounting to 38 million tons food losses (Monier et al., 2010). In Germany, consumers cause two third of food losses, more than half of which were avoidable (Kranert et al., 2012). 20 % of purchased food and 30 % of packaged food was discarded (Rosenbauer, 2011). But food losses occur in households for a variety of reasons. Most commonly, food is discarded due to spoilage, leftovers on the plate or out of date (Koivupuro et al., 2012) and is wasted although it has been suitable for human consumption. This can mainly be attributed to individuals purchasing too much, using unsuitable or insufficient storage practices, out of date, finding the food unsavory either to the nose or the palate, forgetting to freeze food properly, cooking too much or simply not using leftovers

(WRAP, 2008; Koivupuro et al., 2012; Cox & Downing, 2013). According to WRAP (2008), 1.2 million tons of food valued at 1.6 billion EUR is discarded on the basis of leftovers on the plate in the UK. Additionally, 0.8 million tons (1.75 billion EUR worth) are wasted due to expired best-before-dates, 0.7 million tons (1.4 billion EUR worth) due to a bad smell, taste or appearance, 0.4 million tons (0.8 billion EUR worth) due to spoilage and 0.6 million tons (0.7 billion EUR worth) due to not using leftovers from cooking (ibid). Consumers show a lack of awareness for the quantity of food losses occurring in their households. Moreover, consumers have a low level of awareness in terms of the environmental damages caused by food losses (Quested et al., 2011). In light of the aforementioned results, Farr-Wharton et al. (2014) identified three key factors that account for food losses in households: (1) consumers do not know what food they still have at home, (2) consumers lack of knowledge how food is stored and (3) it has not been proven how and to what extent past experiences and acquired knowledge influence purchasing decisions or waste behaviour (ibid).

The foremost motivator for consumers in reducing food losses is the desire not to waste money (Baker et al., 2009; Graham-Rowe et al., 2014). Twice the number of consumers state that saving money would be the main reason to reduce food losses as ecological benefits resulting from minimising food losses (Baker et al., 2009). Further motivations in terms of reducing food losses are seen in concerns towards waste, doing the right thing, guilt and awareness about poverty and hunger (Baker et al., 2009; Quested et al., 2011; Graham-Rowe et al., 2014). Thus, by reducing food losses, environmental damages can also be minimised without additional costs for the government (Baker et al., 2009). That said, food planning can facilitate the minimisation of food losses. However, there are also barriers relating to reducing food losses, as an excellent food supply or no responsibilities. Additional absent priorities and interest in this area are also a real barrier to minimising food losses, given that many consumers already consider themselves to have their food and waste planning under control and are satisfied with their own behaviour in this respect (Graham-Rowe et al., 2014). Other consumers are also indifferent to a certain extent and, for example, think that food losses do not have harmful effects on the environment, or do not perceive the issue as a problem (Cox & Downing, 2013; Graham-Rowe et al., 2014). Even the retail sector presents a barrier for effective strategies in reducing food losses, as their profits depend on sales volumes (Baker et al., 2009).

Food waste behaviour is influenced to a greater extent by purchasing routines than by intentions of wasting less food (Stefan et al., 2013). Mostly, consumers are taken aback when con-

fronted by that fact that they are wasting food and feel guilty. They are aware how to avoid food losses, but do not adhere to their tips. For example, many consumers think that purchase planning can reduce food losses. Nevertheless, purchase decisions often are made spontaneously in retail environments (Baker et al., 2009). Given this fact, food losses arise due to an interaction of different behaviour in food planning, purchasing, storage, preparation or consumption (Quested et al., 2011). Some food is not purchased because of consumer requirements regarding optical properties, freshness, shelf life, variety or availability. For example, fruit and vegetables are often left in the fields due to cosmetic standards which have been developed to correspond to consumer requirements. An interaction of different multipliers is necessary for a real minimisation of food losses (Beretta et al., 2013). The prevention of food losses is strongly linked to consumer behaviour, which is, in the case of avoiding food losses, not simply vosible for others, compared to other environmental protection activities like recycling (Quested et al., 2013). For this reason, many consumers are willing to recycle household waste (Martin et al., 2006). This leads to the importance of social norms and the visibility of an individual's effort for reducing food losses (Quested et al., 2013).

Some factors leading to food losses in households require the government intervention, while others are better remedied by the food industry itself, such as providing information about food storage or improving the comprehension of shelf time, for example (Parfitt et al., 2010). In Belgium, 80 % of consumers are familiar with the label "best-before-date" or "use-by-date" and 70 % also know the difference between these labels. Consumers assess if food is edible or not by simply looking, smelling or tasting the product or looking at the best-before-date. After the expiry of the best-before-date, fewer frozen products are eaten in comparison to products stored at an ambient temperature. The best-before-date is therefore used as a standard value and is open to flexible interpretation, depending on the type of food (Van Boxstael et al., 2014). Additionally, suitable packaging solutions that protect products in retail environments, during the distribution and in households can lead to lower food losses and environmental damages (Silvenius et al., 2014). Often, due to ill-suited packaging, food is wasted because packages are too large, cannot be emptied properly or due to the expiry of the best-before-date (Williams et al., 2012).

Overall, the quantity of food losses is also affected by socio-demographical factors, like size of household, the gender that is responsible for food purchasing, guidelines for reducing food losses or settings regarding the impact of the purchase of particular packaging sizes (Koivupuro et al., 2012). But only single socio-demographical factors in the investigation of

Koivupuro et al. (2012) demonstrated statistically significant differences in terms of avoiding food losses. There was one clear correlation between the quantity of food losses and the number of persons living in a household (ibid). Single-Person households waste more food when compared to other household sizes on a per capita basis (WRAP, 2008; Quested et al., 2011; Koivupuro et al., 2012). In this respect, food losses increase with rising household size (WRAP, 2008; Baker et al., 2009). Households where women are responsible for purchasing have greater amount of food losses than households where men or both women and men are responsible for purchasing (Koivupuro et al., 2012). Contrary to some investigations, like Quested et al. (2011), Parfitt et al. (2010) or WRAP (2008), who stated that older people waste lower quantities of food, Koivupuro et al. (2012) could not find a correlation between age and the quantity of food losses (ibid). Additionally, Baker et al. (2009) and Parfitt et al. (2010) declared a correlation between income and quantity of food losses, which rises with increasing household income.

Methods

Conceptual framework

Currently, there is no standardised method of obtaining data on the quantity of food losses in households and each study about food losses or food waste generally employs another definition on this basis or uses different classifications when addressing the topic. Due to this fact, several studies are not comparable with each other (Lebersorger & Schneider, 2011). In the literature both terms “food waste” and “food losses” are used, whereby the terms are demarcated differently. For this reason, simply the term “food losses” will be used, which comprises all food rests occurring along the supply chain, meaning avoidable, partly avoidable and unavoidable food left-overs.

To compare data about costs of food losses, costs are stated uniformly in EUR, and foreign currencies are converted from the original currency into EUR according to the average annual reference price of the German Bundesbank (Deutsche Bundesbank, 2015).

Data acquisition

The study was carried out by 25 test households in Germany, who kept a diary within seven days in the period from August until November 2014. The households could start the testing

phase individually and were obliged to start when they had an ordinary week to avoid falsifications through untypical behaviour which did not correspond to typical daily habits. Each household received four questionnaires to list their food storage, their food purchases, their food losses and their guidelines or attitudes towards food, as well as outlining the demographical aspects of the household. At the beginning of the testing phase, a guide with background information was distributed to each household, including details about the study and instructions on how to fill out the questionnaires. Furthermore, the guide contained educational information about the term food losses, which was defined as food that has been produced for human consumption, but is not consumed by humans. It was also clarified that food that was used to feed animals or beverages that were not consumed count as food losses as well. According to this definition, each day households were to list all food and beverages that were produced for human consumption but wasted in their household. A distinction between avoidable, partly avoidable and not avoidable food losses was not a task that was to undertaken by the households and was to be declared with the corresponding list of food losses. For every food wasted, the cause for wastage could be listed in the food categories of bakery products, fruit, vegetables, fish / meat, dairy products, food rests, rests of preparation, beverages and others. These categories were split into subcategories that could be extended by the household in accordance with their food losses. Quantities of food losses were not gathered in this study. The focus was particularly on causes of purchasing and wasting food.

Process of the study

The case study proceeded in three main steps as can be seen in figure 1. First, the testing household was to check their food storage and list what food they have at home and what food they select afterwards. In the field phase, the households were to note within seven days every food they bought as well as every food they wasted and why they bought or wasted these foods. In the end, general settings about food were captured as well as demographical aspects.

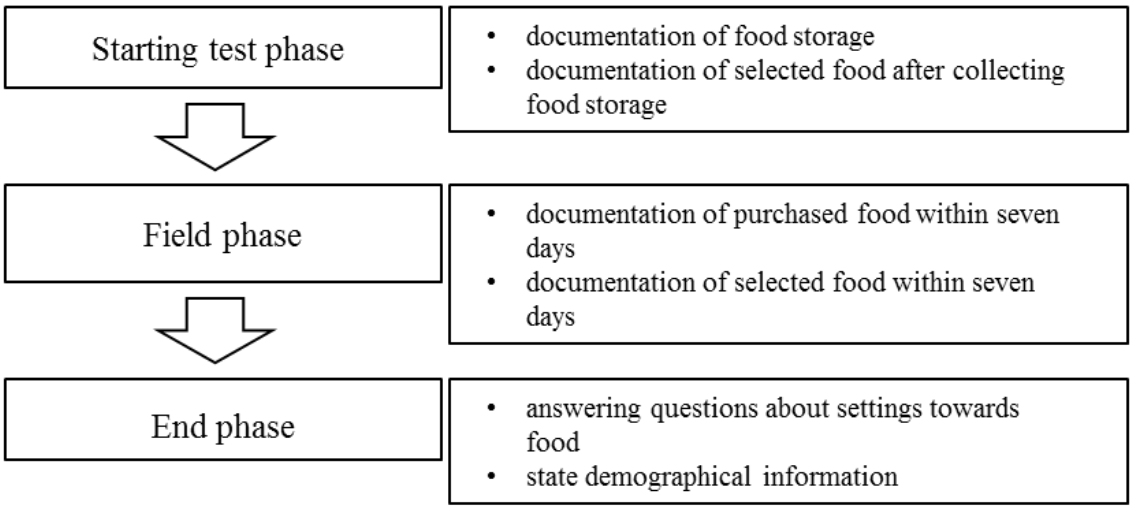

Figure 1: Order of the case study
Source: Author`s representation

Data analysis

The data were entered into the statistic and analysis software IBM SPSS and then evaluated by univariate and bivariate analysis methods. The univariate analysis examines single variables and presents them based on absolute and relative frequencies. Bivariate analysis methods investigate coherences between two or more variables. The presentation is done by cross tables or comparison of mean values (Berekoven et al., 2009; Koch, 2009; Kuß und Eisend, 2010; Backhaus et al., 2011). In cross tables, combinations of two or more variables were opposed in a matrix and the abundance of the appearance of single combination possibilities were indicated in a matrix.

Results

Sample Characteristics

The case study was conducted with 25 households in Germany. Table 1 represents the main characteristics of the sample. Mainly Two-Person households participated in the study. Children lived in nearly one-third of the households, mostly younger than six years of age. Four states of Germany are represented in the study: Baden-Wuerttemberg (1), Berlin (5), Brandenburg (5) and North-Rhine Westphalia (12). The net income per household demonstrated a broad range: less than 1,500 EUR (10), 1,501 – 3,000 EUR (5), 3,001 – 4,500 EUR (5) and more than 4,500 EUR (4). The educational level was above average. In thirteen households, at

least one individual had a university degree. Further, in the sample, most persons in the households were between 30 – 40 years old. Only in one household did the participants have a higher age, over 60 years old.

Table 1: Sample characteristics

		Quantity of Households
Household size	Single-Person household	6
	Two-Person household	16
	More than Two-Person household	1
Children	One child	4
	Two children	4
	More than two children	1
State	Baden Wuerttemberg	1
	Berlin	5
	Brandenburg	5
	North Rhine Westphalia	12
Net household income	< 1,500 EUR	10
	1,501 – 3,000 EUR	5
	3,001 – 4,500 EUR	5
	> 4,500 EUR	4
Education	Certificate of secondary education	2
	Secondary school certificate	4
	A-level	2
	University degree	13
	Another education	2
Age	20 – 30 years	5
	31 – 40 years	10
	41 – 50 years	4
	51 – 60 years	3
	Older than 60 years	1

Source: Author`s calculation

In total, these sample characteristics are not representative for Germany. But also due to the small sample size, the results could not provide any conclusions to the behaviour of German households in general. The objective was rather to show trends and possibilities, and what can hypothetically be gleaned from the German case for further investigations.

Results of the case study

Food purchase, storage and losses

The food purchase, storage and waste behaviours of the 25 test households were very different. Most common dairy products, as well as products from other categories, including vegetables, fruit and bakery products were all bought during the monitored period. Pasta products were purchased least. Therefore, mostly food products were bought because they were absent in the particular household or purchased on a regular basis. Yet food is also often bought due to appetite or when encountering special offers in a retail setting. At the minimum, food was

purchased only once a week, ranging up to every day. On average, every household purchased food 3.24 times in seven days.

Product categories that were most commonly stored were others, especially spices, gain products or sweets, dairy products, vegetables, beverages or fruit. Of these, mostly vegetables, fruit, others and dairy products were selected after checking food storage. According to the quantity of stored foods, every second product of bakery products, every third product of vegetables and fruit and every fourth product of dairy products and meat / fish were disposed of. The most common reasons for the removal to waste were moulded foods or spoiled foods, as well as the expiry of the best-before-date.

In everyday life, the greatest number of food losses occurs through food preparation. Furthermore, vegetables and fruit are often wasted. The least amount of waste comes with pasta products, beverages and meat / fish during the testing phase. Of these, most common food was wasted because there were inedible ingredients or rests of skin. Additionally, food was discarded because it was bought or cooked too much, moulded or spoiled or due to the fact that they possessed inadequate sensory characteristics, in terms of taste, smell or appearance.

Classification of households according to their waste behaviour

The test households can be classified into three groups according to the quantity of wasted food: households with high food losses, moderate food losses or low food losses. Table 2 shows the characteristics of households classified by the quantity of wasted food and sorted by quantity, from high to low.

Table 2: Classification of households according to the quantity of food losses

	Number of purchases	Costs of purchases (in EUR)	Number of spontaneous purchase causes	Household size		Monthly net income (in EUR)	Education
				adults	children		
High food losses	1	75	6	2	1	> 4,500	university
	6	309	22	2	2	> 4,500	university
	4	76	9	2	2	3,001-3,500	university
	3	176	17	2	2	> 4,500	university
	2	104	9	2	-	1,001-1,500	university
	2	23	2	1	-	1,501-2,000	university
	3	61	6	1	-	1,001-1,500	university
	3	62	2	2	-	3,501-4,000	A-level
	7	209	14	2	2	3,001-3,500	others
	4	199	12	2	-	1,001-1,500	university

	Number of purchases	Costs of purchases (in EUR)	Number of spontaneous purchase causes	Household size		Monthly net income (in EUR)	Education
				adults	children		
Moderate food losses	2	40	5	1	-	2,001-2,500	-
	5	66	8	2	4	1,001-1,500	A-level
	6	84	5	2	-	> 4,500	university
	7	204	11	2	-	> 4,500	university
	1	35	7	-	-	1,501-2,000	others
	2	16	3	2	-	2,001-2,500	ssc*
	7	33	1	1	-	1,001-1,500	university
Low food losses	2	-	2	2	-	501-1,000	cse**
	2	50	6	2	1	3,001-3,500	cse**
	2	18	-	1	-	3,001-3,500	university
	2	91	8	4	1	1,001-1,500	university
	1	-	1	2	-	1,001-1,500	ssc*
	2	-	5	2	-	1,001-1,500	ssc*
	4	62	13	2	1	2,501-3,000	university
	1	-	1	1	-	1,001-1,500	ssc*

*Secondary school certificate
**Certificate of secondary education

Source: Author`s calculation

In this sample, households with high food losses purchase food 3.5 times a week on average, amounting to 129.40 EUR worth per week or 36.90 EUR worth per purchase. Households with high food losses purchase food several times a week and have higher expenditures for food. Additionally, these households tend more often to buy food more often spontaneously. Households in this group are composed of families with one or two children or one or two persons. The net household income is higher, mainly above 3,000 EUR per month. Additionally, the education is higher, too, and at least one member has a university degree in nearly all the households.

Households with moderate food losses purchase food at an average of 3 times a week, amounting to 68.97 EUR per week or 15.93 EUR per purchase. These households buy food several times a week and in some cases buy food spontaneously, but not to that extent households with high food losses do. The household size is determined by two-person households with a monthly net household income between 1,000 – 2,500 EUR. The educational level is different, from secondary school certificate, A-level or university degree.

Households with low food losses buy food on average 2.5 times a week, at a value of 55.25 EUR per week or 22.10 EUR per purchase. These households purchase food mainly one or two times a week and tend to be less spontaneous when buying food. The weekly expenditures for food are the least of the groups. The household size is characterised by two-person households and families with one child. The monthly net household income is different, from 500 to 1,500 EUR or 2,500 to 3,500 EUR. The educational level is lower. Mainly

the highest degrees of the household members are secondary school certificate or certificate of secondary education, lesser have a university degree.

In total, households with high food losses purchase food most frequently and most common spontaneously. Further, these households have the highest expenditures for food. But in comparison households with moderate food losses show the lowest expenditures for food per purchase. According to the highest expenditures, households in the group of high food losses have the highest net household income, but also the highest education.

Comprehensive Discussion and Conclusion

Food purchase, storage and wastage

The case study for charting purchase decisions as well as causes for selecting food in different German households showed that consumer behaviour is quite varied and is characterised by individual attributes according to the purchase and selection of food. Most commonly, dairy products, others, vegetables, fruit and bakery products were purchased. These products comprised bakery products, also components of food storage in households. Thus most common vegetables and fruit were removed from food storage. And also in daily life vegetables and fruit were discarded most often during food preparation. Even the results of Cofresco (2011) and Kranert et al. (2012) show that mostly fruit and vegetables are wasted, whereby food scraps from preparation are already included in the categories and not listed additionally (ibid). The causes of food selection can mainly be traced back to insufficient meal planning. These results correspond to results of Cofresco (2011), where 59 % of wasted food can be traced back to insufficient purchase planning or storage (ibid). Stored food was wasted after checking for mould on products, spoiled products or the expiry of the best-before-date. In daily life, food was discarded because too much food was purchased or cooked, products had mould or bad sensory characteristics (taste, smell or appearance). Also, in other studies. The most common reasons for food losses are: spoilage, too much food purchased, careless storage, expiry of the best-before-date, bad sensory characteristics, too much purchased or served, or not using food scraps (WRAP, 2008; Baker et al., 2009; Monier et al., 2010; BMEL, 2011; Koivupuro et al., 2012; Cox & Downing, 2013). Thus, food losses occur in households mainly due to insufficient meal planning.

Classification of households according to their waste behaviour

Households could be divided into three groups, corresponding to the amount and frequency of food wasted: households with high food losses, with moderate food losses and low food losses. It can be observed that households with high food losses purchase food several times a week and more often spontaneously. This suggests that in these households, meals are planned to a low extent or even day by day. An increasing number of food purchases also goes hand in hand with an increasing frequency of spontaneous purchases. Farr-Wharton et al. (2014) mentioned that a factor responsible for food losses is that consumers do not know what food they have at home (ibid). This can lead to an increased number of spontaneous purchases and can be avoided by meal planning. Additionally, the expenditures for food are considerably higher in this group, more than twice in comparison to households with moderate or low food losses. Parizeau et al. (2015) perceived a positive correlation about the height of expenditures for food and the amount of discarded food. By increasing expenditures, the amount of food losses also increased (ibid). Even the net household incomes of households with high food losses are higher than in the other groups. The study of Parfitt et al. (2010) has observed that the amount of food losses increases with increasing income (ibid). According to the results of the Forsa survey on behalf of the federal ministry for food and agriculture (BMEL), food is discarded most commonly by persons aged between thirty and forty, the working population, pupils and students, and those of a formal higher educational level and a higher net household income (BMEL, 2011). Collectively, the net household income is the highest in households with high food losses. Also in the group of households with moderate or low food losses are separate households who have a high net household income, but select food less frequently. Consequently, the expenditures for food in these households exceeds the average expenses of the respective group, and even the amount of spontaneous purchases is higher.

Additional households with high food losses also feature a higher educational level. In almost all households, at least one member has a university degree. In households with moderate food losses at least one member has A-level and in households with low food losses the educational level is different, whereby persons of this group mainly have a secondary school certificate or a certificate of secondary education. Even the results of the Forsa survey showed that persons with higher educational levels more often discard food. For example, two-thirds of the test persons stated that they select food quite rarely. By contrast, only one-third of the test persons with an A-level or university degree stated that they rarely select food (BMEL, 2011). Due to a higher income, the appreciation of food could be viewed as considerably low-

er than in households with low income. According to results of the Forsa survey on behalf of the BMEL, test persons with lower incomes stated more frequently that they had a guilty conscience when they discarded food. By contrast, test persons possessing a higher educational level more seldom expressed having a guilty conscience by wasting food (BMEL, 2011). Compared to households with lower food losses, households with high food losses purchase food more often spontaneously. There is better meal planning, while the number of purchases and especially the spontaneous purchases are lower. Overall, it could be concluded that households with lower income consider meal planning much more seriously, purchase food less spontaneously and have, overall, a higher appreciation of food.

Final considerations

In total, the results indicate that food losses occur mainly due to absent or insufficient meal planning. Morevoer, whether or not there is a lower appreciation of food in connection with the greater size of the net household income could ultimately not be assessed because this was not charted in the case study. However, objectively it could be ascertained that food selection could be avoided or reduced by more efficient meal planning. Yet how can consumers be directed to plan food purchases, to consume food when it is edible and fresh or to not consider the best-before-date as a parameter for wasting food? Regarding this, Graham-Rowe et al. (2014) stated, that the issue of food losses is not perceived as a problem (ibid). Some initiatives are already in effect which deal with consumer education in this context. In Germany, for example, the initiative "Zu gut für die Tonne" (too good for trash can) has been employed on behalf of the BMEL, raising consumers' awareness for this issue and encouraging consumers to use food leftovers and not to waste food which has best-before-date (BMEL, 2015). In the United Kingdom, for example, WRAP cooperates with partners and brings together retail, food industry and consumers with the objective of reducing food losses. Some approaches pursued included offering different package sizes, enabling consumers to purchase the right amount of food, and development of innovative package functions to keep food longer fresh (Quested et al., 2011). Even the study of Halloran et al. (2014) concluded that packaging systems may have an influence according to the amount of food waste in households (ibid). Additionally, Baker et al. (2009) and Graham-Rowe et al. (2014) stated that saving money would be a key factor in reducing food losses (ibid). These results should be considered in future initiatives to minimise food losses. But it is difficult to assess who is

addressed by these measures and if getting through to individuals who do not inform themselves about food is possible in this manner. Further, it is necessary to verify whether the results are comparable to Germany and why food losses are higher in households with higher educational level and net household income. Therefore, households have to be characterised and categorised and persons with high and low food losses have to be identified to develop suitable guidelines and initiatives which lead to lower food losses and to emphasise at which stage of the supply chain it has to be set in order to direct consumer behaviour towards a responsible handling of food.

Limitations of this case study and recommendations for further research

In this case study, the handling of food was investigated in 25 German households. The main objective was to capture causes and reasons for food losses and for purchases as well as to characterise households according to their amount of food losses. In accordance with the sample size within the study, only trends could be shown which should be investigated more precisely in future research projects. Additionally, the sample size is not representative for the German population based on national distribution, educational level, age and net household income. Thus, statements concerning these aspects were made within the analysis but should be viewed in consideration of the small sample size and the non-representative character of the sample.

The elevation of causes for purchase or selection of food was carried out by using questionnaires and is based on the information provided by the participating households which was not checked. Despite providing precise instructions for filling out the questionnaires and a handbook about the progress of the study including explanatory information, the study could contain misinformation.

Overall, the case study records trends in handling food which should be investigated in further research projects. It should especially be verified whether or not food losses can be avoided through better meal planning and what measures are suitable for directing consumer behaviour towards a more efficient handling of food. It is therefore necessary to identify groups of consumers who are especially suitable for addressing with respect to this issue.

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