THÜNEN

Food waste in private households in Germany

– Analysis of findings of a representative survey conducted by GfK SE in 2016/2017 –

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Abstract

From July 2016 to June 2017, the market research company GfK SE introduced the first representative diary study on food waste in German private households. Almost 7,000 households recorded and reported about their handling of food waste (FW) over a period of 14 days each. The study distinguished between avoidable and unavoidable FW and leftovers. The present report introduces the methodology and the findings of that study and also provides comments and recommendations by Thünen Institute (German Federal Research Institute for Rural Areas, Forestry and Fisheries) for future replications from a scientific point of view.

The GfK study provides many new insights into how FW is handled in private households in Germany and offers basic knowledge for developing new policy options for reducing food waste. In particular, the type and composition of the discarded foods provides detailed indications of key issues, e.g. 16 % of avoidable FW is cooked / prepared (with a very high energy input). In some cases well-known reasons for disposal are confirmed, and classified in their importance for the topic, such as the result related to the best-before date (BBD): Only 5.8 % of respondents indicate this as a disposal reason. Overall, 57.6 % of food is thrown away due to ´problems related to durability´, 36.6 % were spoiled.

When interpreting the results one should bear in mind that carryover effects can obscure the root causes of food disposal, e.g. suboptimal shopping behaviour causes problems regarding durability. Thus, the most important disposal reasons could be reduced by more planned and needs-based shopping and proper storage and processing at home. But this would take much more time, which may seem disproportionate to many consumers.

It should be underlined that the extrapolated values for the total food waste of just under 4.4 million tons are to be considered as the lower threshold. About 44 % of this food waste was considered avoidable by the surveyed households. Thus, there is a theoretical potential for improvement, which could be specifically addressed by using additional information from more detailed surveys.

JEL: D12

Keywords: Food waste, household, representative survey, diary survey, prevention, Germany.

Zusammenfassung

Das Marktforschungsunternehmen GfK SE erfasste von Juli 2016 bis Juni 2017 erstmals im Rahmen einer repräsentativen Tagebuchstudie systematisch die Lebensmittelabfälle in deutschen Privathaushalten. Fast 7.000 Haushalte wurden über einen Zeitraum von je 14 Tagen über ihren Umgang mit Lebensmitteln und Lebensmittelabfällen (LMA) befragt. Die Studie unterschied sowohl vermeidbare als auch unvermeidbare Lebensmittelabfälle und Speisereste.

Grundsätzlich liefert die GfK-Studie viele neue Erkenntnisse über den Umgang mit Lebensmittelabfällen in privaten Haushalten in Deutschland und ist eine gute Grundlage für die Entwicklung neuer politischer Handlungsoptionen zur Verminderung dieser Abfälle. Insbesondere die Art und Zusammensetzung der entsorgten Lebensmittel gibt detaillierte Hinweise auf zentrale Probleme, z. B. sind 16 % der vermeidbaren LMA „Gekochtes/Zubereitetes" (mit einem sehr hohen Energieinput). Zum Teil werden bekannte Wegwerfgründe in ihrer Bedeutsamkeit zur Bearbeitung des Themas neu eingeordnet, wie beispielsweise das Ergebnis zum Mindesthaltbarkeitsdatum (MHD): Nur 5,8 % der Befragten geben dies als Wegwerfgrund an. Insgesamt werden 57,6 % der Lebensmittel wegen „Haltbarkeitsproblemen" weggeworfen, 36,6 % davon waren verdorben.

Bei der Interpretation der Ergebnisse ist insbesondere darauf zu achten, dass Überlagerungseffekte die eigentlichen Ursachen für das Wegwerfen von Lebensmitteln verschleiern können, z. B. führt suboptimales Einkaufsverhalten zu Problemen bei der Haltbarkeit. So könnte den wichtigsten Wegwerfgründen durch planvolleres und bedarfsgerechtes Einkaufen sowie sachgerechte Lagerung und Verarbeitung begegnet werden. Dies würde aber v. a. einen zeitlichen Mehraufwand erfordern, der für viele Konsumenten unverhältnismäßig erscheinen mag.

Es ist zu unterstreichen, dass der hochgerechnete Wert zum Gesamtaufkommen an Lebensmittelabfällen von knapp 4,4 Mio. t als unterer Schwellwert anzusehen ist. Etwa 44 % dieser Lebensmittelabfälle wurden von den befragten Haushalten als vermeidbar eingestuft. Es zeigt sich also ein theoretisches Verbesserungspotential, welches mit Hilfe der zusätzlich erhobenen Detailinformationen gezielt adressiert werden kann.

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List of Abbreviations

A	
a	anno (year)
B	
BMEL	Bundesministerium für Ernährung und Landwirtschaft (German Federal Ministry of Food and Agriculture)
D	
d	day
F	
FAO	Food and Agriculture Organisation of the United Nations
G	
g	gram(s)
GfK SE	market research company named „Gesellschaft für Konsumforschung" (old), „Growth from Knowledge" (new)
H	
HH	household
K	
kg	kilogram(s)
M	
m	month
Mio.	millions
N	
NEMONIT	Deutsches Nationales Ernährungsmonitoring (German National Food Monitoring)
P	
PHH	persons per household
R	
REFOWAS	Pathways to reduce food waste (German research project)
T	
t	ton(s)
TNNr.	number of participant in questionnaire

1   Introduction

Food waste plays a key role in the context of sustainable nutrition. Around one third of food produced for human consumption is thrown away (Gustavsson et al., 2011). Some of this waste is put to other uses, such as animal feed or compost. Some ends up in residual waste and is incinerated. The percentage of waste that ends in residual waste should be minimised in the interest of sustainability (economic, ecological, social[1]). Policy-makers are also promoting a social discourse on and positive developments towards a greater appreciation of foodstuffs and allocating scientific support to this endeavour. International studies suggest that, in industrialised countries, most of the food waste generated along the entire value-added chain is generated in private households (Gustavsson et al., 2011). Thus, theoretically at least, the largest potential for reducing waste lies in the consumer sector.

In 2015, the United Nations' General Assembly unanimously adopted the so-called Agenda 2030 (United Nations, 2015). This Agenda sets out 17 sustainability objectives (Sustainable Development Goals, SDGs) with a total of 169 sub-goals for sustainable global development. Sub-goal 12.3 of Agenda 2030 calls for the following "*By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses"*. Germany is also committed to achieving these goals and will, in future, report corresponding figures to the United Nations on a regular basis.

At the same time, work is underway on a requirement for all Member States of the European Union how much food is wasted. Participants in the subgroup "Measuring of food waste" of the EU Platform on Food Losses and Food Waste[2] are devising a common approach to recording food waste in EU Member States. The legal requirements of general food law (Regulation (EC) no 178/2002) and the revised Waste Framework Directive (Council of the European Union, 2017) lay down the definitions of food waste, system limits, methods, the information to be reported and a schedule. An accompanying delegated decision establishing a common EU methodology to measure food waste has been adopted by the European Commission on May 3rd 2019. If no objection is raised by the European Parliament and the Council, the delegated act will be published and enter into force in autumn 2019.

Against this backdrop, BMEL initiated a consumer survey on the handling of food waste in 2016 (BMEL, 2017a). On behalf of the BMEL, the market research company GfK SE systematically recorded and analysed food waste in private households in Germany from July 2016 until June 2017 as part of a representative diary study. The report comprises the first representative study covering German households (GfK SE, 2017) that addressed the following questions, inter alia:

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[1]   Social sustainability comprises societal aspects such as health, hunger, occupational safety and health, culture and ethics etc.

[2]   Please see the website https://ec.europa.eu/food/safety/food_waste/eu_actions/eu-platform_en for information on the platform.

- How often is food waste generated in households and how much?

- Differentiation between avoidable and unavoidable waste?

- Are there any differences relating to the number of persons in the household, age and region?

- Why is food thrown away in the household?

- Which disposal routes are used?

In order to be able to develop and implement suitable measures to reduce food waste in private households, detailed information must be available, for example on consumer knowledge of and attitudes towards food, purchasing habits, food storage, preparation and consumption, disposal routes and mechanisms behind the generation of food waste in everyday life. The first GfK SE (2017) surveys can serve as a basis for developing measures. Regular follow-up surveys are designed to review changes, to guide the measures taken and to evaluate the impact in the long run. To this end, surveys need to be planned and implemented in such a way that they are

- comparable over the years;

- statistically corroborated (i.e. a sufficiently large sample is chosen); and

- the results are evaluated in line with statistical rules (e.g. verification of the statistical meaningfulness of the outcome, taking structural conditions into account in the evaluation).

The above-mentioned study, for the first time, provides valuable and representative insights into German households' handling of food waste. As federal research institutes, we consider it our duty to take the results of the above report on board and place it in a scientific and strategic context. This Working Paper aims to

- discuss the results in connection with already available information from Germany;

- identify restrictions in the validity of available results;

- outline a possible use of results as the beginning of a time series;

- indicate currently still unused information content of the results;

- work out conclusions with a view to long-term recommendations for action and strategies for a continuous monitoring of food waste in private households; and

- compile an evidence base for policy-makers.

The structure of this Working Paper is based on the initial evaluation and outcome documentation of GfK SE (2017) in German. In order to enable readers to use the Working Paper chapter by chapter, the results of the GfK report are briefly and individually outlined one after the other, comments are made in each chapter from a scientific and contextual perspective and this is then followed by recommendations. The issues can thus be viewed in isolation. Cross-references foster an inclusive approach.

2   Background

In 2012, an initial nationwide estimation of the food waste generated in German households was conducted on the basis of secondary data from official statistics, research and corporate reports and random sampling surveys (Hafner et al., 2012). The data base comprised, for example, waste sorting analyses from some German federal states and non-representative polls in households. Data gaps emerged, for instance, in the case of discarded beverages that had to date not been included in literature data or food disposed of via the sewage system (drainage), fed to domestic animals or used for home composting. The missing data were supplemented by plausible assumptions from international literature to enable an estimation of the total amount of discarded foodstuffs in German households. The results served as a general estimation of the overall scale of discarded food, per 4-capita household and per person, the avoidable and partly avoidable percentage, the composition of the waste according to product groups, the disposal routes used by households and the financial impact on the household.

An ongoing study concludes that around 40 % of avoidable food waste in Germany arises in private households (cf. REFOWAS research project[3]). When it comes to modelling the value-added chain, this study, too, is mainly built on secondary data from statistics. Whereas relatively reliable statements can be made about the absolute waste amount through statistics and waste analyses, little is known about the causes of food waste and differences between various types and sizes of households in Germany. Current surveys such as the BMEL Nutrition Report (BMEL, 2017b), a German Environment Agency (UBA) study on "Environmental awareness in Germany 2016" (BMUB, 2017) and the National Nutrition Monitoring Survey (NEMONIT) - analysed under the REFOWAS project - provide important information in this respect. However, more extensive information, allowing conclusions to be drawn regarding both consumer behaviour and reference points for policy options, is needed to act as a basis for a national strategy process aimed at preventing food waste. Some international studies already address this challenge (Elimelech et al., 2018; Delley and Brunner, 2017; Ogwueleka, 2013; Schneider, 2016).

The survey commissioned by BMEL in 2016 (GfK SE, 2017) examined, for the first time in a representative manner[4], what foods were discarded, how much of each food was discarded, and why it was discarded, by means of diary recordings in German households. In doing so, the survey also recorded what disposal route was chosen for the respective foodstuff. In combination with individual characteristics of participating households such as age, place of residence, number of children etc., specific questions could be designed and used to develop target group-specific measures in future.

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[3]   The final REFOWAS report is expected to be available from summer 2019.

[4]   In this context, "representative" means that the households surveyed can be deemed representative of all German households.

3   Survey methodology, definition and empirical data

3.1   Survey design

Data from the GfK ConsumerScope Panel[5], covering almost 7,000 households, were used in order to answer unresolved questions on the issue of food waste in private households. The heads of household entered their handling of food waste in diaries over a fortnightly period, with around 500 households being assigned a specific 14-day section between July 2016 and June 2017. A total of over 200,000 diary entries were evaluated. This Working Paper Annex 1 contains a summary description and a copy of the diary that was specifically developed for this purpose. The questionnaire is printed in full in the annex to the GfK report. In this context, the interviewees had to estimate the type and quantity of food waste and decide whether the waste was avoidable or unavoidable. The results were broken down according to the age of the head of the household, the size of the household (number of persons), the seasons or months, and the macro-region (3 to 5 federal states respectively).

Food waste was recorded in the diaries by means of an identification number scheme. Discarded food was classified and entered in a list, with the following data being noted:

- Date: Date of disposal

- Identification number: What food waste/leftover food has arisen/has been disposed of?

- Reason for disposal: Why has the food waste arisen/why was leftover food disposed of?

- Characteristic: In what condition was the food/leftover food discarded?

- Disposal route: Where did the discarded food/leftover food end up?

- Volume: How much was discarded (quantity/number/unit)?

In addition, the questionnaire assigned a serial number to households linked to the age of the head of household and the number of persons in the household.

Unavoidable food waste was designated as "unusable or inedible" and more precisely identified by means of six identifiers for "peel, cores, ...´, ´bones, skin, ...´, ´coffee grounds´, ´coffee pads´, ´teabags/ tee dregs´, ´unusable for other reasons´. The percentages that were basically still edible, (and thus also avoidable), were divided into 116 product categories.

The fortnightly recordings per participating household were deemed representative and extrapolated to an entire month. In the case of leftover food, it was assumed that it would be particularly difficult for the interviewees to estimate the mass due to the existing mix of several

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[5]   http://www.gfk.com/de/loesungen/verbraucherpanel/

food categories (e.g. noodles with meat and sauce). Past experience gathered by GfK SE showed that leftover food had been consistently underestimated in terms of quantity. Therefore, all leftovers recorded by households were multiplied by the factor 1.2.

The task of participating households was to record all food discarded by the household. Even if households were very meticulous in their approach, gaps can emerge in the process such as forgetfulness due to stress in everyday life or if food is taken on a trip away from home or discarded away from home (e.g. in schools or in the office[6]). In the latter case, the person keeping the diary might not even be aware of this. In order to estimate this so-called coverage gap, the volumes of recorded food waste were compared with the foodstuffs purchased: the results of the GfK household panel were used for this purpose in order to be able to set out the average quantity of food purchased in German households. Background information on the percentage of edible and inedible constituents was available for most of the foodstuffs under scrutiny. Thus, every banana purchased consists of an edible interior and a skin that is regarded as inedible. With the help of conversion factors and with due regard to the total food amounts discarded, the amounts of food purchased were converted into the corresponding levels of inedible food waste. This result was compared with the recorded amounts of inedible food waste from participating households and it was noted that the reported levels from the households were too low (by up to 19 %). Except for leftover food, all recorded waste amounts were therefore multiplied by a factor of 1.18 in order to offset the gaps in coverage described above. The rectified quantities were subsequently extrapolated to the entire federal territory using the current statistical data on the number of households in Germany.

GfK SE defined unavoidable food waste as "*all parts of a foodstuff that is basically unfit for human consumption*". This includes, for example, bones, fish bones, egg shells, cores, skins, stalks and also coffee grounds. Whether a discarded foodstuff is seen as avoidable by the respondents was recorded by the question as to the reason for disposal, which distinguished between "unusable/inedible food waste/leftover food". GfK SE itself indicated that manifestly incorrect categorisations on unavoidability, e.g. for milk and bread rolls, had been rectified in the course of data editing. Nevertheless, it is assumed that the respondents slightly overrated the "unavoidable" share and underrated the "avoidable "share.

3.2   Placing the chosen method in a scientific context

The diary study was selected as the survey methodology. It has both advantages and disadvantages for the specific objective pursued here. The fact that theoretically all waste accumulating in the household can be included/registered can be considered to be an advantage of the diary survey. By contrast, other methods that are frequently employed such as waste

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[6] Around 57 % of the German workforce, pupils or students, on a daily basis or very frequently, take food from home to the workplace, school or university (BMEL, 2017b).

sorting analyses can only record the quantities that are disposed of via waste collection schemes based on containers or bags. These surveys do not take account of any food waste that is fed to domestic animals, disposed of via the sewage system or composted at home in one's own garden because the method cannot record it. However, GfK SE also observed a discrepancy in its report between the waste recorded in the shopping section and the theoretical amount of waste when extrapolated backwards (based on the food reported as discarded in the questionnaires). This gap was closed by the coverage method, which is considered to be a reliable approach.

Diary studies are classified as reactive or direct measurement techniques (Diekmann, 2006) and record the behaviour reported by the interviewees and not the behaviour itself (Atteslander, 2006). An interaction occurs between the measuring method and the subject which is called the "Hawthorne effect". This means that the very fact that the participant is aware of being part of a (scientific) survey modifies his behaviour (Diekmann, 2006). The participants in the GfK survey are experienced panel test households and it can be assumed that questionnaires such as the one used here are part of their (daily) routine. Yet it cannot be ruled out that the Hawthorne effect exerts an influence. It is, however, impossible to evaluate how it affects the results.

There are indications in literature suggesting that the question regarding the discarded food volume is crucial in a reactive measuring method (cf. Schneider, 2016; Van Herpen et al., 2016). The mechanism of "socially desirable answers" is responsible for this. Each person has a different perception of society's positive assessment of individual actions, views or other characteristics related to a specific issue. He or she gets an idea of how socially desirable conduct in society should look like. The greater the distance between perceived behaviour and his or her own behaviour, the greater is the bias in the answers in a poll. A subject who believes that throwing away food is seen as reprehensible in his reference society will bring his reported behaviour into line with this ideal. To what extent the actual quantities are being underestimated cannot be specified for this particular study.

Compared with other survey methods, the diary method used has the advantage that the interviewees knew their task for the 14 days to come and were accordingly able to record the amount of food discarded directly after it was discarded. By contrast, we should critically challenge survey methods that ask participants to estimate quantities regarding events in the past (e.g. 24 h recalls in food consumption surveys) with respect to quantitative data (cf. Dämon and Widhalm, 2003; Rathje and Murphy, 2001).

In order to make it easier for the interviewees to estimate the amount of food discarded and to minimise the workload, the participants in the GfK survey were permitted to indicate the amounts in grams, litres or by number. The participants were given a conversion table for a simple estimation of the mass per foodstuff/peel/dish. Even though these levels are, according to GfK SE, based on many years of experience, this approach causes major uncertainty as regards the estimation of discarded quantities. How many participants actually weighed their food waste was not recorded.

The extrapolation to Germany as a whole is based on the assumption that the food waste accumulating in the household within the fortnightly period under review is representative of the entire month. The participating households were asked not to take part in the survey during any holidays or to wait until the holiday has ended before starting the survey. It is, however, seen as relatively unlikely that no food waste at all, not even unavoidable food waste, will arise in one month if people are actively living in the household. Due to the relatively low share of households without any food waste (5 %, see chapter 5.1.1), the influence exerted by this uncertainty on the overall outcome is estimated to be rather small. Yet it underlines the view that the masses calculated here are to be seen as the lower limit.

From a scientific perspective we must ask ourselves anyway whether the aim of a household survey should be an absolute quantity survey or whether preference should primarily be given to qualitative information. The survey of discarded food waste amounts is less useful for extrapolating the overall amount of household food waste throughout the country than for ascertaining the relevance of the disposal routes used in each case. Information about attitudes and conduct prevailing in the household can also be obtained through qualitative methods. Surveying the amounts of food waste exclusively within one sector can conceal the quantities that cannot be assigned to a specific sector along the value-added chain. Ideally, sectoral calculations provide additional detailed information over and above a holistic view of the entire value-added chain; they cannot, however, replace the latter at (inter-)national level (cf. Xue et al., 2017). The FAO's supply balance sheets are a well-known example of consistent, multisector surveys that will in future also be used to calculate the Global Food Loss Index (Fabi, 2017). Methods such as the macroeconomic mass balances (cf. Liu, 2017) or input-output models (cf. Schmidt, 2017) are also being suggested at international level.

Generally speaking it should be noted that the approach pursued by GfK SE to include both avoidable and also unavoidable food waste in the survey is endorsed from a scientific point of view. An overall analysis of all food waste, followed by a breakdown of the data, provides a more comprehensible framework for the study and reduces the risk of households omitting small quantities of avoidable food waste. If the survey is restricted to avoidable categories alone, laziness may result in one or the other foodstuff is omitted rather than going to the trouble of entering it (e. g. the few carrots that went mouldy that are disposed of together with the carrot peels). This question hardly arises for respondents if all food waste is surveyed.

The interviewees themselves categorised whether the accumulated food waste should be deemed "avoidable" or "unavoidable". Thus, this categorisation was not pre-determined in a standardised manner and is therefore prone to a certain subjectivity. GfK SE itself pointed out that while the share of "unavoidable" waste may be overrated, the share of "avoidable" waste may be underrated. This assessment is much in line with the above-mentioned aspect of "socially desirable answers" which certainly plays a role in this case.

The selection of the indices "avoidable" and "unavoidable" is regarded as being appropriate and allows for a substantiated analysis. Measures relating to the waste classified as "avoidable" can be specifically developed from the outcome. It will also become clear how much waste that is classified as "unavoidable" arises and where it ends up. Using appropriate methods, this waste can also be put to a more efficient use as part of an optimised separate collection (e.g. via material recycling in composting or biogas plants).

The use of the term "unusable" in the diary to describe "unavoidable" food waste is seen as somewhat unfortunate. For one thing, a uniform definition of the term should be used that runs like a thread throughout the diary and report. On the other hand, terms and definitions should be used that leave participants little room for interpretation.

Not making the distinction between "avoidable" and "unavoidable" would remove the subjectivity of the categorisation; however, this would also cause individual differences to be lost. In the present case, people report on their individual handling of food, which depends on the situation and on many other constant influencing factors. Take potato peel, for instance. Whether the peel is eaten or not is determined by the variety and type of preparation as well as by personal preferences. It will therefore probably, depending on the case, either be eaten or it will be thrown away, classified as "unavoidable" food waste and reported accordingly. While this may result in an imprecision when determining the amount of food waste in the categories, this must be set against the benefit of more detailed information which is beneficial for deriving measures.

On account of the numerous estimations, the extrapolation results are subject to a degree of uncertainty; this uncertainty could be more precisely analysed and quantified through additional surveys.

4   Results

4.1   Household coverage

4.1.1   Household coverage according to GfK SE

Food waste concerns virtually all German households. 95 % of households questioned stated that they generally throw away food. Most of them (87 %) reported that this also included avoidable waste. According to GfK SE, these levels constitute the absolute minimum, since it can be presumed that a part of the waste classified as unavoidable should, viewed objectively, be categorised as avoidable.

Only 5 % of households questioned recorded no waste at all during the period of diary recordings, which can also be attributed to the relatively short observation period.

4.1.2   Placing the household coverage in a scientific context

As a result of the presumed underreporting (due to social desirability) and also the relatively brief fortnightly period covered per household, it can, however, be assumed that the share of households that incur food waste, and also of those that incur avoidable food waste, is higher than reported. It can be assumed that, to a lesser or greater extent, large quantities of (avoidable) food waste are thrown away in each German household within a year. Extrapolating the findings to Germany as a whole using only 95 % of households therefore carries a known level of imprecision. However, this only serves to underline the conclusion drawn by GfK SE that the issue of food waste avoidance affects virtually all German households and therefore constitutes a subject that is relevant to society. In addition, the extrapolation provides a lower threshold level of the presumed amount of food waste.

4.2   Total mass of food waste

4.2.1   Total mass according to GfK SE

The extrapolation of the reported food waste in the households questioned to all German households resulted in a sum of 3.7 million tons of food waste in the period covered from July 2016 to June 2017. The so-called coverage method was applied in the extrapolation in order to take the gaps in the survey described in Chapter 3.1. into account. This rectified the food waste documented with regard to the representatively surveyed purchases. An average gap of 15 % was identified in this specific application, i.e. the waste amounts specified in the diaries correspond to only 85 % of the mass of waste which can plausibly be accounted for. Thus, the actual levels are slightly higher than 3.7 million tons, amounting to 4.4 million tons of food waste in private

households in Germany per year. This corresponds to 109 kg per household and year or around 300 g per household and day. Based on the average statistical household size of around 2 persons per household in Germany, this therefore results in a food waste amount of 150 g per person and day.

44 % of all recorded food waste was categorised as avoidable by the households themselves. In light of the assumption that households are more likely to classify food waste as unavoidable, GfK SE roughly estimates that one half of waste is avoidable and one half unavoidable.

According to GfK SE there are strong fluctuations in food waste amounts over the year. It is in winter months especially that higher levels are recorded than in most summer months. Months containing public holidays that are linked to celebratory meals, such as December (Christmas days), stand out in particular. It should, however, be mentioned that the causes of waste generation vary from season to season (see Chapter 5.3.1). Figure 1 shows the levels of avoidable and unavoidable food waste broken down by months and region.

Figure 1:   **Amount of all food waste (avoidable and unavoidable) in private households by months and region**[7]
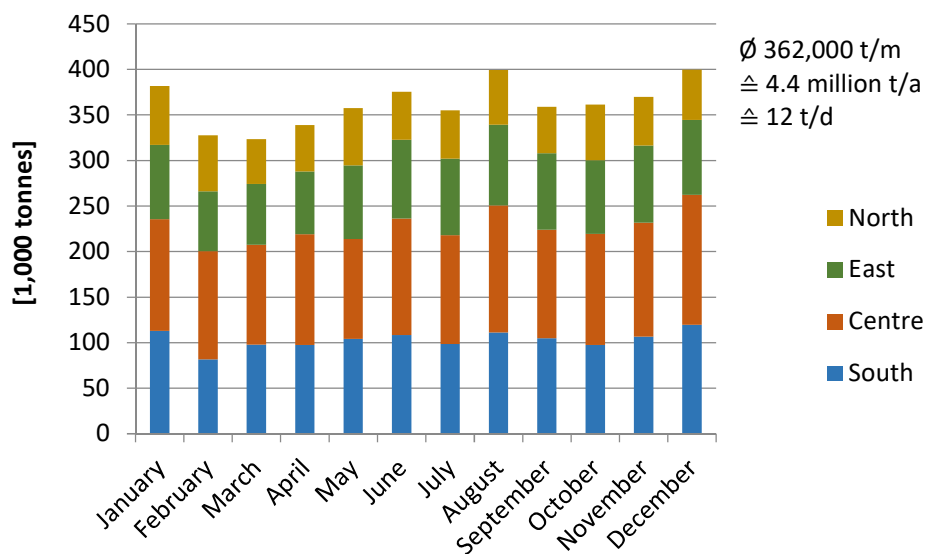
Source: Own diagram based on BMEL data, 2017a.

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[7]   The federal states of Saarland, Rhineland-Palatinate, Hesse and North Rhine-Westphalia are summarised as the "centre".

4.2.2   Placing the total mass in a scientific context

An estimation of the avoidability by reporting households should be seen as subjective. With the chosen method, it was left up to the households themselves to determine whether food waste was to be classified as "avoidable" or not. While GfK SE notes this fact, it does not have any consequences for the extrapolation. As older studies (Hafner et al., 2012) confirm that the percentage of avoidable food waste is of this magnitude, albeit using a different methodology, this can be deemed an acceptable error.

The authors of this Working Paper believe that seasonal fluctuations and regional differences do not show any clear trend (cf. Figure 1). Apparent differences between regions in Fig. 1 may primarily be related to the number of households covered per region and may not be indicative of different disposal behaviour. The months where most waste is generated were August and December and the months with the lowest levels of waste were February and March. These need to be statistically analysed, however, in order to be able to derive sound scientific statements on food waste amounts over the year. Only then will any significant variations become evident, allowing corresponding conclusions to be drawn for practice.

4.3   Composition of food waste

4.3.1   Composition of avoidable food waste according to GfK SE

The results show in detail that fresh fruit and vegetables, on a par with each other at around 17 %, can be classified as the foodstuffs that are discarded most of all (Figure 2). Cooked/prepared food comes second at 16 %, followed by bread and baked goods at around 14 %, beverages at almost 11 %, milk products at over 9 %, convenience, deep frozen and canned meat and vegetable products at around 7 %, other food at just over 5 % and fresh meat, sausages and fresh fish at around 4 %.

Figure 2:   **Composition of avoidable food waste by product groups**
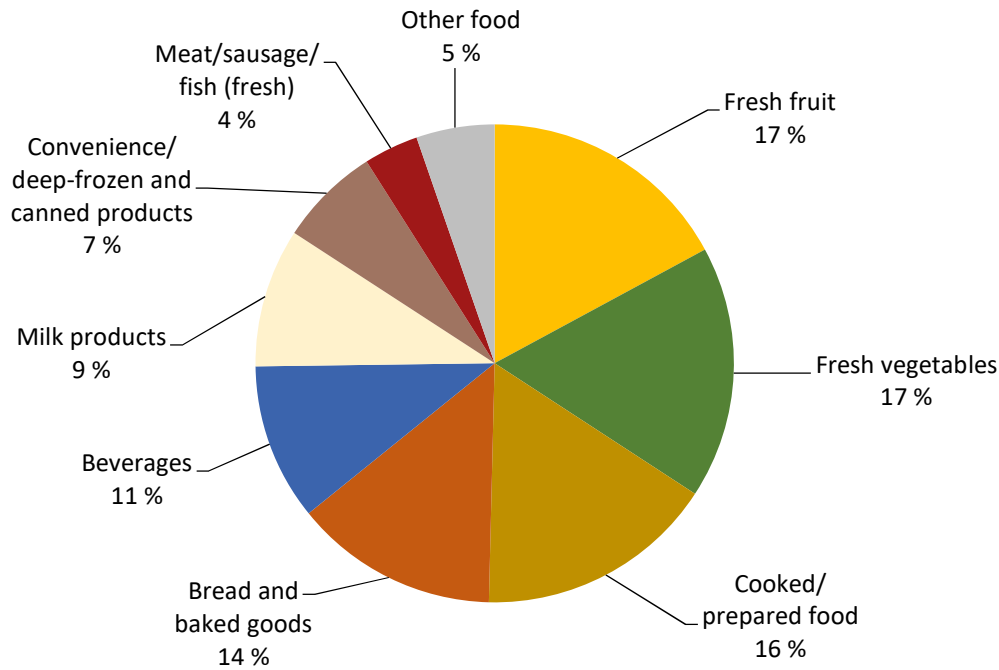
The analysis showed seasonal variations in discarded product groups (Figure 3). Fresh fruit and vegetables account for higher shares in the summer months. In the case of fruit, apples made up the highest waste levels in July and August, berry fruits were frequently recorded in May and June and citrus fruits were more strongly represented in the results of the winter months.

Months with established public holidays such as Easter and Christmas showed increased waste levels in the cooked/prepared category which suggests leftovers from celebratory meals. There is a possible connection between public holidays and the avoidable beverage waste levels in November and December where it is likely that warm beverages are prepared ahead and subsequently disposed of.

Figure 3:   **Seasonal variations in avoidable food waste by months (proportions in % of the types of food)**
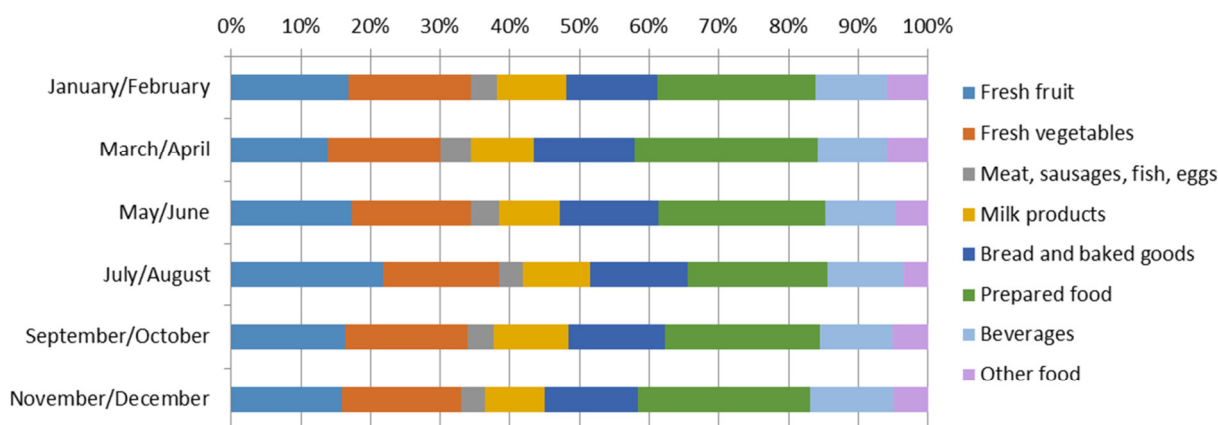
4.3.2   Placing the composition in a scientific context

Apart from the mass percentages of recorded discarded types of food, the time and resources needed for primary production, processing and preparation should also be taken into account in an interpretation. Thus, the preparation of cooked and prepared food already involves some deployment of human and energy resources in the household and throwing them away means that this effort was in vain.

The food categories of bread and bakery products, beverages and milk products (a total of 34 %) are generally regarded as highly processed. This means that while considerable resources were consumed along the value-added chain, the intended benefit (consumption) was not achieved in the end.

Even though ready-made and deep-frozen products can, as a rule, be stored for a longer period of time than fresh products due to their long shelf-life, these products also make up some of the food that is disposed of. Similar to the situation above, both these product groups also involve a higher energy input due to the high level of processing required for ready-to-eat dishes and the low temperature needed to store deep-frozen and refrigerated ready-to-eat products. The intended benefit of consumption was not achieved in respect of these types of food either, a fact which points to inefficiencies.

Even though fresh meat, sausages and fresh fish play a seemingly minor role by mass in avoidable food waste (just under 4 %), they give rise to major ecological and ethical problems on account of the high level of resources they require (water, feed, land etc.) Particular attention must be paid to this point, given that at least 13 % of all avoidable food waste comprises animal products

(sausages, fresh meat, fresh fish, milk products, partly also in baked goods, ready-to-eat products, cooked foods and beverages).

Before specific measures focusing on product groups are developed to reduce food waste, the results of the diary study should therefore be considered in relation to sustainability aspects instead of purely in relation to mass-related indicators.

The authors fail to understand the statement by GfK SE about the high share of vegetables in the summer months. According to Figure 3, vegetables reached their highest percentage in September and October, at 17.7 %, whereas they only accounted for 16.7% in July and August and 17.2 % in May and June. It is generally the case this evaluation also did not provide any statistically significant differences; a substantiated conclusion as to seasonality can therefore not be drawn.

4.4   Reasons for the generation of avoidable food waste

4.4.1   Reasons for the generation of avoidable food waste according to GfK SE

The spoilage and unsavouriness/age of food turned out to be the main reason for food disposal. The respondents noted that the food disposed by them included just below 58 % of spoiled food or food that had gone bad and was visually unsavoury/old/no longer tasty or food that was past its best-before date (BBD).

Quantity-related problems at home account for the second largest percentage of avoidable food waste at around 21 %. In these cases, food is disposed of because too much was cooked and, less frequently, because too much food was served on plates.

At just under 12 %, quantity-related problems make up the third largest share of avoidable food waste. The primary cause of this lies in large pack sizes. Special offers that relate to (overly) large packs or to several packs being purchased, and poor planning of purchases are also significant.

Other reasons, accounting for just under 8 %, include causes such as "doesn't taste nice", burnt, too salty, incorrectly stored, accidents such as falling out of the fridge etc.

Figure 4:   **Reasons for the generation of avoidable food waste**
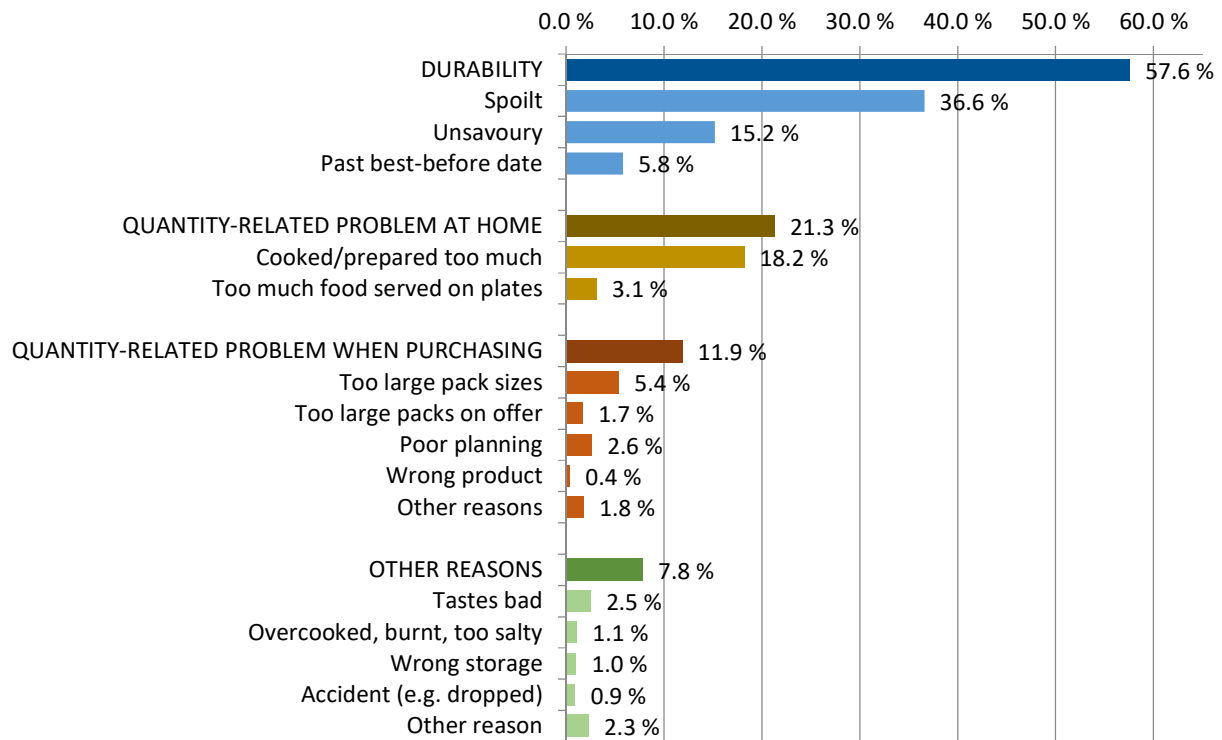
GfK SE note in their outcome report that the reasons given are also to a degree interdependent. This means that foods go off or get old because they are being prepared or purchased in overly large quantities.

Food being past its best-before date was only given as a reason for disposal for just under 6 % of avoidable food waste. Despite the fact that a lot of fruit, vegetables, baked products and meat products do not have any best-before date at all, this figure is still considered remarkable. In addition to indicating the main reason for disposal, participants were also able to state a second reason in the questionnaire. In addition to passing the BBD being given as the main reason in just under 6 % of cases, this was also given as the second reason in a further one percent of cases. One-person households reported that best-before dates played a greater role (8.2 % gave the best-before date as a reason) than this was the case in larger households (6.6 % for two-person households, 5.7 % for three+-person households).

Of the product groups that are most frequently disposed of due to passing their best-before date, milk products clearly top the list at just over 32 %, followed by convenience and deep-frozen products at 13 %. This is attributed, firstly, to the fact that, in respect of milk products, there are only fairly short periods before the products reach their best-before dates and, secondly, that the price of milk products is comparatively low. This means that, in balancing this with risk minimisation, throwing these products away causes hardly any dissonance or bad conscience.

The category of "Other foods", which includes ketchup, dips etc., ranks third among the product groups that are thrown away due to having passed their best-before date. While the product groups contained in the "other foods" category mostly have longer best-before dates, they still account for around 12 % of the foodstuffs thrown away for this reason. GfK SE attributes this to a low intensity of use, with barbecue sauces, for instance, being chiefly used during the barbecue season. If they are not used up by the end of the season, they are forgotten and ultimately thrown away.

4.4.2   Placing the reasons in a scientific context

When using the diary recordings to ask why food was disposed of, it needs to be remembered that the respondent enters the reason that applies at the moment the food is disposed of. However, the process ranging from the planning of purchases to the discarding of food is very complex and the actual underlying cause of disposal is often superimposed by subsequent reasons. Thus, for example, an orange may be thrown away because it went mouldy. The interviewee would probably give "spoilage" as the reason. If the orange was bought in a large mesh bag and was not eaten in time because there were too many oranges in the bag, the problem is not spoilage but the quantity bought. Unplanned business trips or eating out of home on the spur of the moment can also upset meal plans and result in food spoilage. The results, in particular regarding the reasons why food was disposed of, should be seen as assessments by the heads of household and mirror the planned or unplanned sequences of events in the household. Yet they must be interpreted in order to draw conclusions in respect of measures. There is also evidence of the best-before date being used as an excuse or justification for disposing of food in order to appease a person's conscience (Hafner et al., 2012). Similar observations were reported by Evans (2011), who claimed in detailed interviews with test households that it is only in some cases that people keep partly consumed foodstuffs or food leftovers in the refrigerator in order to still have the option of eating them later on. However, in most cases, people do not seize this opportunity and the leftovers are thrown away. This is one way of appeasing one's own guilty conscience, with spoilage being used as an excuse.

The outcome report of the diary survey recommends taking a closer look at best-before dates as the reason for food disposal. The analysis of NEMONIT data 2012/2013 revealed that while only 7 % of interviewees generally throw away food that is past its best-before date, the majority of interviewees examine whether these foodstuffs are still usable (Koch et al., 2017). In recent years, the debate on the perception of best-before dates in general and on consumers' dietary decisions has intensified. In a Forsa survey conducted in March 2012 (BMEL, 2012), 81 % of Germans questioned stated that they had heard of or read about the discussion on best-before dates in the media. 19 % of interviewees had already noted changes in their attitude towards

food caused by this public debate. Partial results from the GfK consumer panel[8] yield a more up-to-date assessment. One question reproduced in Figure 12 concerns the targeted purchase of products that have been "reduced because they have passed their best-before date". No fewer than one-third of interviewees agreed with this statement in 2016. The question per se is couched in very vague terms since products that are "close to their best-before date" (but not passed it) are offered at discount prices throughout the retail sector. Nevertheless, the answer to the question can be interpreted that at least one third of the population (in the case of specific product groups) handles the expiry of the best-before date in a relaxed manner.

There are now numerous information brochures that point to a manageable risk posed by the intake of food that has passed its best-before date (cf. BMEL, 2015) and list which product groups are, generally speaking, safe to eat for how long after the best-before date has been exceeded (cf. Wiener Tafel, 2016; Verbraucherzentrale Hamburg, 2018). As a result of the ongoing discussion it can be assumed that consumers will increasingly gain more certainty in their own decision-making on which options are open to them when food has reached its best-before date. Inspired by international examples (such as Approved Food in the UK[9]), there are also shops in Germany (in Cologne and Berlin) that successfully sells food to its customers even after the best-before date has expired (Banos Ruiz, 2017; SirPlus, 2017). The idea is already contemplating a nationwide expansion.

Selzer (2010) in her empirical study already critically challenged the relevance of the best-before date as the actual reason for food disposal in households. Products with a best-before date that were disposed of during a stock update in 31 households exceeded the best-before date by an average of 320 days. "Stock update" was defined as meaning the irregular clearing out of store cupboards, cellars etc.. Only 224 out of 553 items of discarded foodstuffs were still in their original packaging. Figure 5 shows the condition in which food was discarded in the GfK SE survey. Here, too, only about 47 % of foodstuffs discarded because of the best-before date were still in the unopened original packaging. Yet the best-before date only applies to unopened packages. Thus a debate on expired best-before dates is mostly redundant in this respect.

A reference to the disposal of produce that is used seasonally can also be found in the literature. The results of Selzer (2010) confirm the disposal of barbecue sauces bought the precious year at the beginning of the new season that was observed in the GfK SE survey. Glanz (2008) established the same connection in the case of specific spices and Christmas.

Bearing the above-mentioned restrictions in mind, it can be assumed that the best-before date plays quite a minor role in food disposal in the household.

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[8]   http://www.gfk.com/de/loesungen/verbraucherpanel

[9]   https://www.approvedfood.co.uk

4.5   Condition of avoidable food waste

4.5.1   Results concerning the condition according to GfK SE

The diary entries show that almost 54 % of discarded food that is classified as avoidable food waste is discarded loose or open. Just under 21 % is thrown away having been prepared or cooked, a further 13 % is thrown away in opened packaging and only 6 % is discarded in unopened packaging (see Figure 5, left).

Figure 5:   **Condition of avoidable food waste**
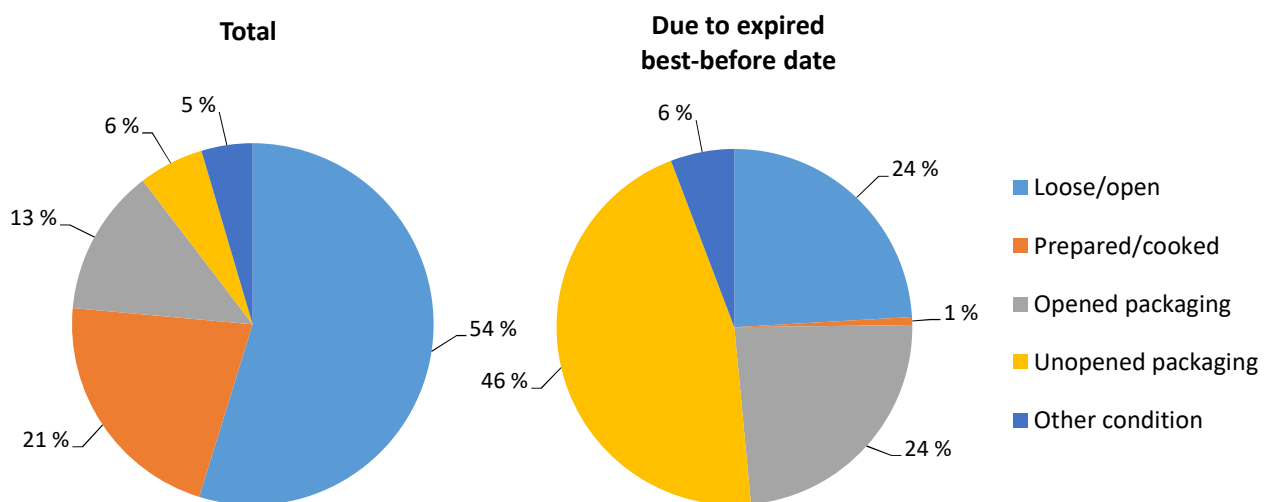
Source: Own diagram based on BMEL data, 2017a.

At just over 31 %, dairy products top the list of foods thrown away unopened, followed by convenience and deep-frozen products and meat and vegetable preserves at almost 22 %. Fresh fruit (just under 28 %), fresh vegetables (22 %) and bread and baked goods (just under 19 %) are foods that are thrown away loose or open particularly commonly.

4.5.2   Placing the condition in a scientific context

In order to plan preventive measures in a more targeted manner, information on the condition of discarded food is very helpful. The results allow us to draw conclusions as to the need for resealable or smaller packaging (if there is a high share of open packages) or if too much is being bought in general (if many loose products or products in original packaging are being discarded).

The statement on the high share of foods discarded in a loose or open condition puts in perspective other proposed solutions to the disposal problem, such as the demands for smaller pack sizes and the discussions about the interpretation of the best-before date, with loose products not even having a BBD. The survey result shown in Figure 5 on the right clearly indicates that the households also regard the best-before date as applicable after the packet has been opened. However, this is, by definition, not the case.

If one only looks at the best-before date as reason for disposal, it turns out that almost 46 % of food concerned is thrown away in unopened packaging (Figure 5). This can be interpreted as meaning that these foods were basically purchased in overly large amounts to stock up on them and were not required. Loose or open products and those in opened packaging are each discarded due to the best-before date in around 24% of the cases. As can be read in chapter 3.5 of the related GfK report, "open/loose" means that the foods have been taken out of their packaging and are disposed of separately from it. This use or interpretation of the terms seems misleading because the products that were actually bought loosely would thus be missing in the selection categories or would not be listed separately[10], which severely restricts the interpretations of results for further preventive measures.
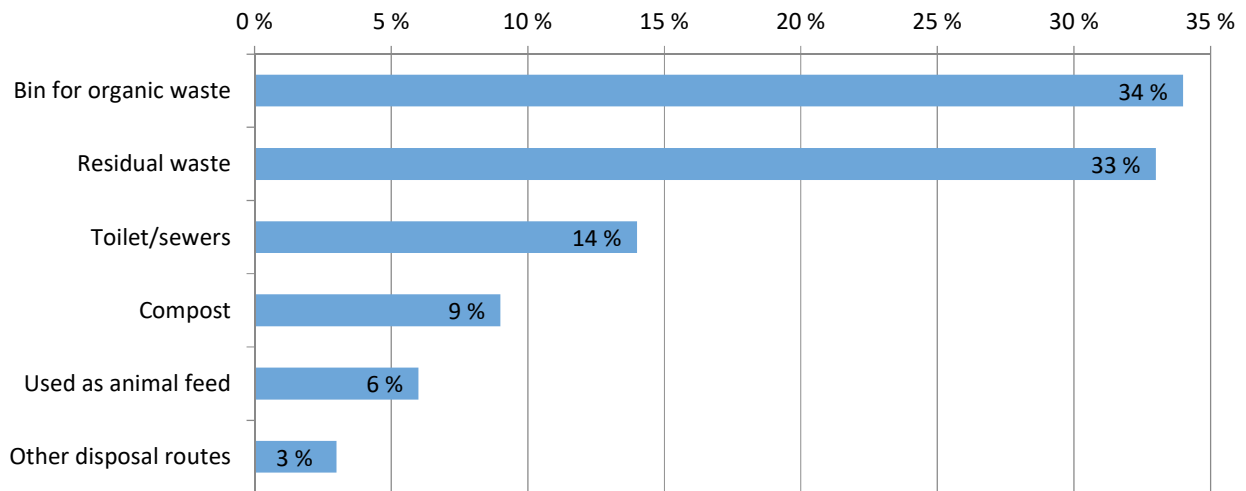
4.6   Disposal routes

4.6.1   Results regarding the disposal routes used according to GfK SE

Figure 6 shows where the avoidable food waste of the households questioned ended up. About one third ended up in the bins for organic waste and one third in residual waste, followed by sewers at 14 %, home composting at 9 % and use as animal feed at 6 %. Around 3 % was discarded via other disposal routes.

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[10]   See also the section in the GfK SE report on page 21 under the heading "Differences by types of packaging".

Figure 6:   **Disposal routes for avoidable food waste used by households**

Households choose the disposal routes depending on the product group (Figure 7). Organic waste bins and composts are chiefly used for the disposal of fresh fruits and vegetables. A high percentage of liquid foods and dairy products are disposed of in toilets or down the drain. Especially bread and backed goods as well as cooked and prepared foods are used as animal feed. Comparatively similar shares of virtually all product groups are disposed of in residual waste.

Figure 7:   **Disposal routes used by households, according to product groups**
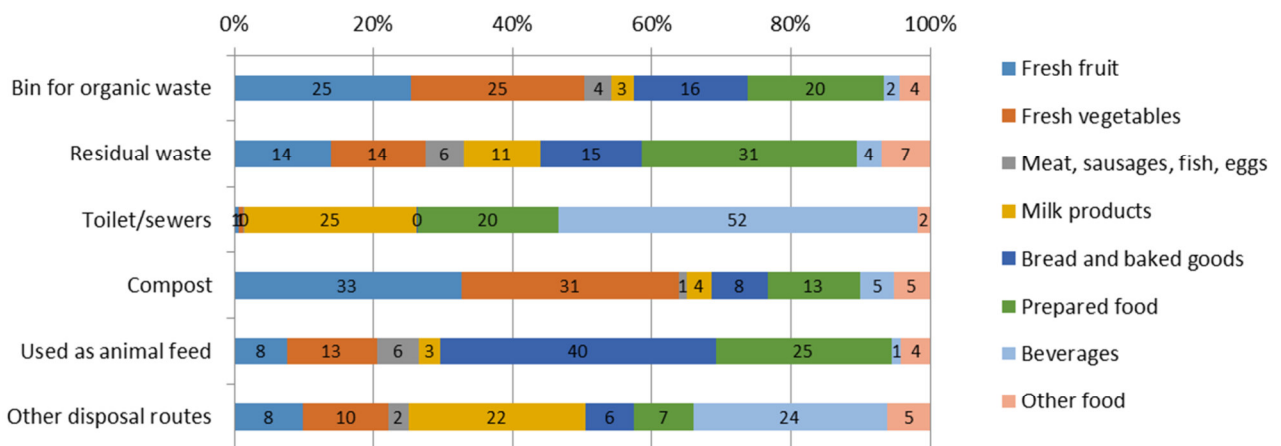
4.6.2 Placing the disposal routes in a scientific context

The results of the disposal routes used are hardly surprising although they, for the first time, constitute a representative result for Germany. But what is interesting is the avoidable food waste adding up to around 3% that is disposed of by means of "other disposal routes". The data base does not explain in detail which options are used by households here. It would be interesting to discover which disposal routes are used in order to be able to take corresponding measures. With respect to the regional differences mentioned by GfK SE it must be noted that these should always be assessed with an eye to specific local circumstances, too (see chapter 5.7. for more details).

There is potential for optimisation as regards the chosen routes of disposal in line with the provisions of local waste management authorities. Even if food is not consumed, it should at least serve a useful purpose such as being used as animal feed for domestic animals or being collected separately in municipal organic waste bins or used for the compost heap at home. The European Union's Waste Framework Directive 2008/98/EC provides a legal basis in this regard. This Directive attaches top priority to preventive measures in a five-level hierarchy. Measures to prepare for reuse rank second, followed by material recovery (e.g. composting, biogas), energy recovery (e.g. incineration) and landfilling as the measure to which the lowest priority is accorded.

The disposal of food via the sewerage system (toilet, drain) causes costly malfunctions in the (household) sewers and sewage treatment plants. Food should therefore, if possible, not be disposed of down the drain. The results of the survey can provide a basis for a corresponding communication strategy.
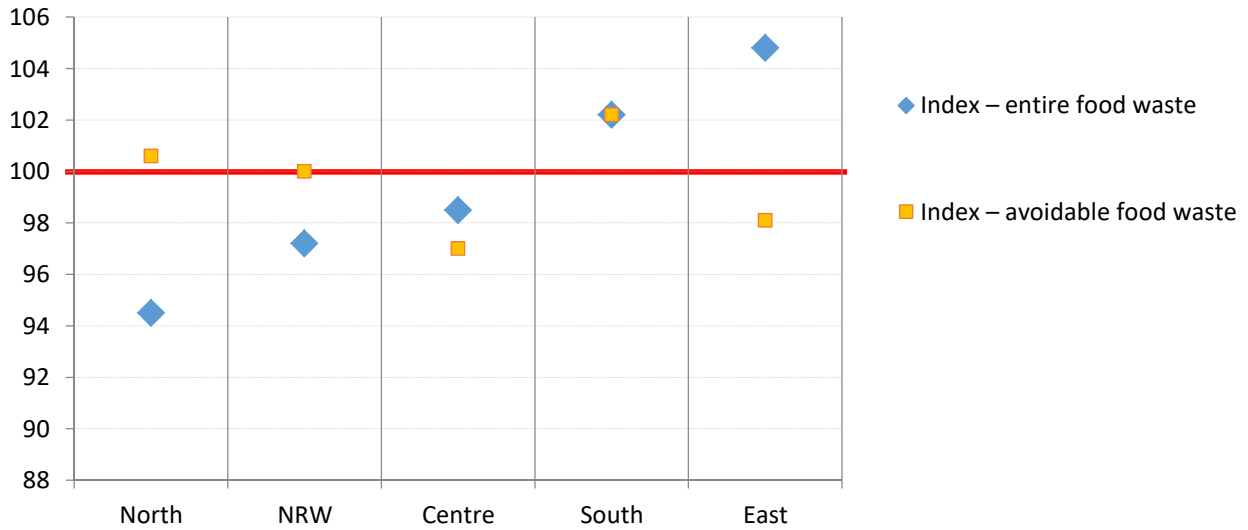
4.7 Regional differences

4.7.1 Results by regions according to GfK SE

GfK SE divides Germany into five regions: North, North Rhine-Westphalia (NRW), centre (Hessen, Rhineland-Palatinate and Saarland), South and East. GfK SE calculated indices in order to make differences in results among the regions under scrutiny comparable. The percentage of the amount of discarded food accounted for by a particular region is then compared with the percentage of the total number of households that this region accounts for.

The comparison in Figure 8 shows that while more food is, in total, disposed of in the East in proportion to the number of households, the share of avoidable food waste tends to be lower. All in all, the results varied little with respect to avoidable food waste.

Figure 8:   **Indices of food waste amount by regions (NRW [North-Rhine Westphalia])**

The analysis of disposal routes by regions in Figure 9 shows areas of higher use of residual waste in North Rhine-Westphalia, whereas organic waste bins play a key role as a disposal route in the central region. Avoidable food waste is comparatively frequently used as animal feed in the East.

Figure 9:   **Disposal routes by regions**
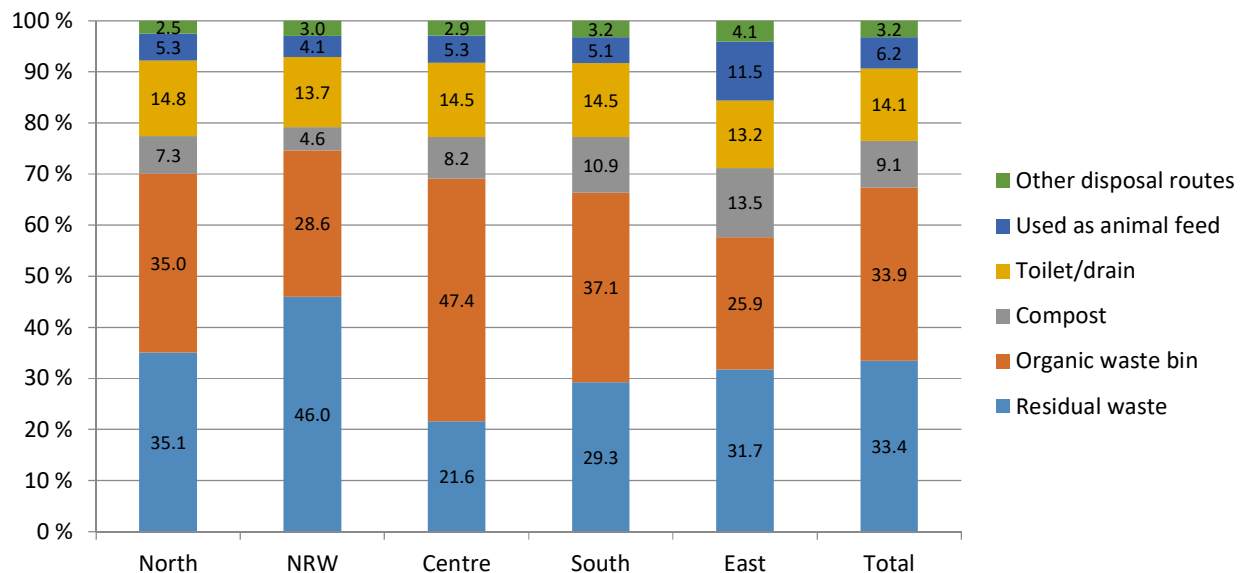
4.7.2   Placing the disposal routes in a scientific context

The introduction of an index to compare regions is deemed necessary and expedient in order to incorporate the different scales in the presentation of results. A level of 100 indicates that a region discards food in proportion to its size. A level of under 100 illustrates that proportionately less food waste arises in a region than would match its size. A level of over 100, by contrast, shows that disproportionately high levels of food are being discarded in this region in proportion to the number of households.

GfK SE accounts for the slightly higher avoidable waste levels in the South compared with the North by pointing to the relatively high share of fresh ingredients. Fresh ingredients translate to a higher degree into unavoidable food waste streams given that more skins, bones etc. arise than if pre-processed foods are used. It may have been assumed that partly consumed fresh products were being disposed of on a larger scale when more fresh food was used. In this specific case, the index in the South is above average both for total food waste generated and for avoidable waste only.

A comparison of regions according to the route of disposal should also take account of the options available to the respective households. These depend, inter alia, on a structural framework such as the provision of organic waste bins by the municipality, or the settlement structure. According to Krause and Oetjen-Dehne (2015), organic waste bins were only available to a limited extent in the eastern federal states in January 2015. While organic waste bins were available almost throughout Saxony-Anhalt, they were only not available, or only available to a limited extent, in Brandenburg, Saxony, Thuringia and Mecklenburg Western-Pomerania. In the light of the above, it comes as no surprise that the organic waste bin in the East has the lowest value by far as a disposal route, when compared with the other regions. The same also applies to the availability of domestic and farm animals, to which leftovers could be fed, or of home composting, which presupposes the existence of appropriate garden areas. The restriction of materials that may be put in the organic waste bin, e.g. municipal bans on putting cooked/prepared food or meat into the bins, could result in organic waste bins being used less frequently as route of disposal.

4.8   Differences according to size of household and age

4.8.1   Results by household size and age according to GfK SE

The amount of food waste that is generated in a household depends, inter alia, on the number of persons in the household. The results of the survey show that as the number of persons in the household rises (1PHH, 2PHH, 3+PHH), the overall waste amount also increases. Figure 10 clearly indicates that while households from three persons upwards (24.6 %) contribute disproportionately to avoidable food waste (38.9 %), smaller households account for a

disproportionately small waste amount in relation to their share. However, if one considers the quantities per capita, one-person households account for the highest food waste amount.

Figure 10:   **Shares of household sizes in the population and the avoidable food waste discarded by them**
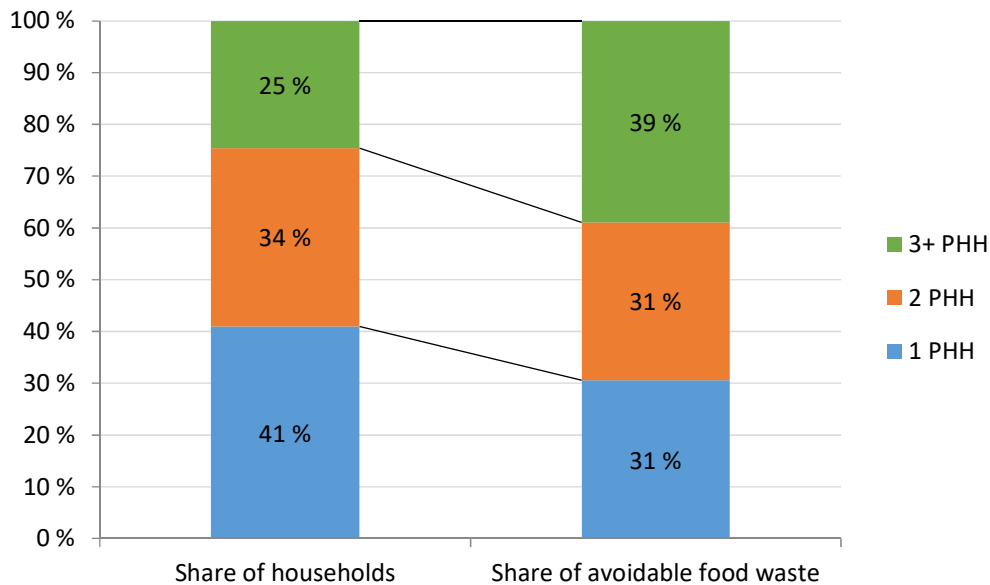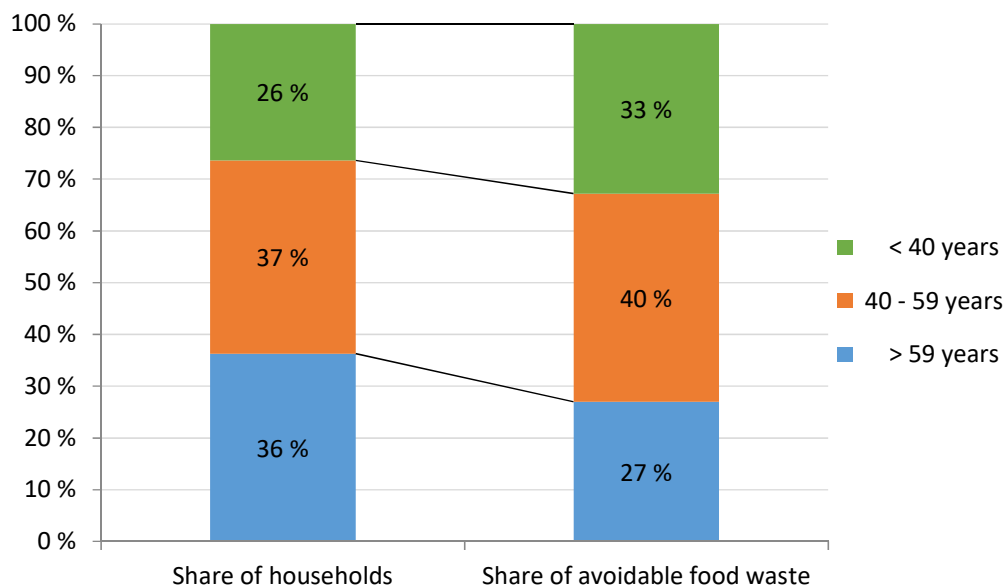

Source: Own diagram based on BMEL data, 2017a.

The questionees in larger households gave ´too much cooked food/having put too much food on the plate´ as the main reason why food was discarded. GfK SE attributed this to the different tastes of the individual family members or food envy among children. By contrast, one-person households tended to report overly large quantities as the reason for discarding avoidable food waste. This can either be ascribed to overly large packing or sales units or, e.g. special offers for multipacks.

A more discriminating look at the results by age suggests a negative connection between food waste amounts and rising age. This means that younger households contribute disproportionately to avoidable food waste. Figure 11 clearly indicates that the 36.3 % of households with the head of household being 60 years of age or older only account for 27 % of avoidable food waste. The two other age groups under consideration contributed disproportionately to the total food waste amount.

Figure 11: **Shares of household sizes in the population and the avoidable food waste discarded by them**

Older households frequently stated overly large quantities as the reason for disposal. This circumstance is interpreted as meaning that older people tend to eat less and cannot cope with the prefabricated pack sizes. Households with members of up to 39 years of age tended to cite ´too much cooked food/too much food on the plate´ as the disposal reason more frequently.

Further analyses by GfK SE revealed that families with children make an above-average contribution to avoidable food waste. Even though only one out of five households questioned had children, they generated around 30 % of all avoidable food waste. The main reason given for food disposal is overly large portions or ´too much prepared´.

4.8.2 Placing the differences according to size of household and age in a scientific context

The links that have been identified between age or household and the reported avoidable food waste discarded essentially confirm the available results in literature (cf. Van Geffen et al., 2017; Jörissen et al., 2015). Yet the result reveals nothing about the underlying reasons. It can be assumed that higher levels of food waste in larger households are due to more complex dietary patterns or daily routine and different preferences of the different members of the household. Different income situations (e.g. lower disposable income in older households) may also have a role to play here and general differences in the attitude towards food disposal (e.g. older people may have personally experienced starvation in their youth). Other studies (e.g. REFOWAS

research project[11]) indicate that households with elderly people cook on a daily basis relatively often. This circumstance may perhaps be an explanation for why more unavoidable food waste arises in older households.

In order to give a more accurate picture of the determining factors and their relevance, it would be necessary to examine the possibility of carrying out detailed analyses of already existing data or including additional information in follow-up surveys.

Given that younger households tend to throw away more food, it would be interesting and desirable to explore in greater detail the disposal behaviour of younger households (e.g. under 29 years of age). However, this is not yet possible since the youngest age category comprises the age group of persons up to 39 years of age. It is unclear how old the youngest persons in this group are.

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[11]   http:/refowas.de

5 Conclusions and outlook

5.1 Conclusion and recommendations by GfK SE

One of the conclusions from GfK SE's diary survey addresses the possibility of being able to make an actual impact on households by means of awareness-raising or information campaigns. Partial results from the GfK consumer panel yield a more up-to-date assessment (ConsumerScan). The question "I deliberately buy less food to stock up on so that I will no longer throw too much away" has been posed since 2010. Whereas only 44 % of households questioned agreed to this statement in 2010, the figure rose to 50 % in 2012. This level has remained more or less stable in the intervening period up until the most recent survey in 2016 (see Figure 12). A trend has also emerged towards accepting products with an expired best-before date that are offered at discount prices in retail trade[12]. Given that such major changes can, based on the experience gained by GfK SE, only very rarely be observed, the conclusion has been drawn that the "Too good for the bin" campaign introduced by BMEL is having a positive influence on the attitudes and awareness of households.

Figure 12: **Agreement to statements concerning awareness-building, share of households agreeing to the statements in percent (by years)**
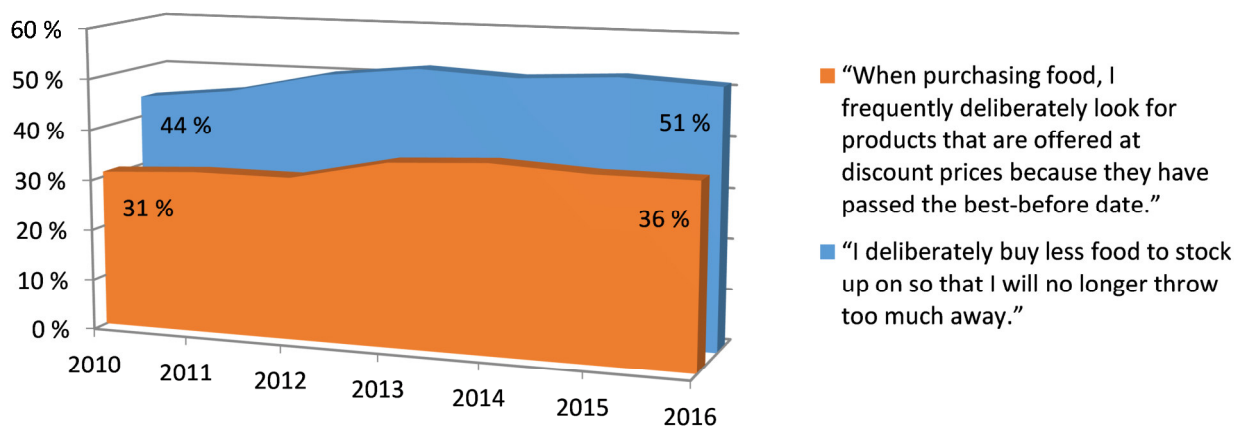
Source: Own diagram based on GfK data - survey from the ConsumerScan 2017.

Based on the available results on the generation of food waste[13], it is deduced that one out of ten foodstuffs is thrown away; this constitutes a change compared with the data in the slogan used in the "Too good for the bin" campaign from 2012, namely that one out of eight foodstuffs is discarded.

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[12] It has to be noted that in practise the BBD of the products is near but not already passed (see also chapter 4.4.2).

[13] given an underlying purchase volume of 43 million tonnes of food (without mineral water).

If avoidable food waste is assigned an average price of EUR 3.13 across all food categories, the value of avoidable food waste discarded in Germany adds up to around EUR 6 billion per year. The means a potential of at least EUR 150 per household per year, which corresponds to around 5 % of expenditure on food.

GfK SE suggests the following as aspects for future awareness-building measures:

- Information on proper and food-specific storage to reduce spoilage.

- Guidance on how foods that become unsightly could be made into tasty dishes with the help of positive connotations, by recalling old craftsmanship traditions and recipes (e.g. French toast) and by involving cooperation partners (such as the retail food industry) or testimonials.

- Information for planning how much needs to be bought, because buying too much ultimately translate into spoilage, inclusion of economic efficiency calculations when purchasing large packages.

Due to the minor relevance of the best-before date, emphasis should only be placed on the best-before date for specific product groups that, in the diary survey, are often discarded due to expiry of the best-before date or for reasons closely related to this. This mainly applies to milk products.

Due to the results, it is also recommended that the action that is taken adopts a target group-specific approach. The overriding focus should be placed on those target groups that show higher waste levels per household. These are primarily families with infants or school children, who above all reported higher levels of leftover food. It is recommended that options are drawn up on how families can prepare leftovers in an innovative and tasty fashion. As an example of co-creation, it is recommended to hold a competition for mothers and children to submit their best recipes for using up scraps and have prizes for these recipes awarded to them by expert chefs. In this way, children can already be made more aware of this issue, too.

Smaller households which cited overly large quantities of food as the main cause were identified as a further target group. Measures regarding pack sizes, food that can be portioned, daily intake and serving sizes should be taken for this target group. A one-person cookery book is cited as an example.

In general, it is recommended to further raise the awareness of German households for greater appreciation of food, with the involvement of actors along the entire value-added chain. Manufacturers and traders should do more in terms of quality and up-trading instead of focusing on sales promotions and sales increase. GfK SE believes that this is an opportune moment, since consumers' focus on quality hit an all-time high in 2017. This means that there is a corresponding acceptance of higher prices for good quality.

5.2   Conclusion and recommendations in a scientific context

5.2.1   General conclusion

The GfK study provides many new insights into the handling of food in private households in Germany and forms a good basis for developing new policy options to reduce food waste. On the positive side, it should be pointed out that the survey contains questions on both avoidable and unavoidable food waste, thereby providing a broad vision of this complex issue. Whereas the prime target of preventive measures is food waste that is classified as avoidable, the information the survey provides on unavoidable food waste offers additional points for how to optimise potential.

It is notably the type and composition of discarded food waste that provides detailed information about key problems, e.g. 16 % of avoidable food waste consists of cooked and prepared food (with a very high energy input). Known reasons for disposal are, in part, confirmed and categorised in terms of their importance for dealing with the subject, such as the results concerning the best-before date: while only 5.8 % of interviewees gave the best-before date as the reason for disposal, 57.6 % referred directly to 'storage life' and 36.6 % described the food wasted as 'spoilt'.

When interpreting the reasons for disposal, attention should in particular be paid to the fact that other aspects may disguise the actual causes of food disposal, e.g. sub-optimal purchasing behaviour causes problems regarding durability. Thus, the key reasons for disposal could be reduced through more methodical shopping and food preparation. However, this could result in households having to spend more time doing these activities which, due to the relatively low monetary value of food waste, does not seem opportune, including for purely economic reasons.

With respect to the changes in the answers given to the questions posed by the GfK Consumer Scan, it should be noted that agreeing to deliberately reduce food stocks in order to avoid food waste (see Figure 12) implies, on the one hand, the realisation that there is a connection between one's own actions and the problem of food waste. On the other hand, it presupposes that individual households are prepared to assume some responsibility for improving the situation. This is very positive. Yet, this fact says nothing about the factor that triggered this increase in awareness from 5 to 7 %. Possible causes may be both diverse public information campaigns at local, regional and national levels and also initiatives by industry and the private sector. Discussions about TV documentaries or on social media may also prompt such a change of mind. All activities mentioned above and many others probably play a role in this change to a greater or lesser extent. Any attempts to directly link this change with the "Too good for the bin" campaign based on a general question on buying in stocks are regarded sceptically. Such a conclusion would have to be based on asking targeted questions to determine to what extent people were aware of the campaign and whether attitudes, motives or behavioural changes were potentially adopted in people's everyday lives due to the content of the campaign.

The reference to a necessary adaptation of the slogan of the "Too good for the bin" campaign needs to be taken into account, given that, firstly, the result constitutes a low threshold and, secondly, that a direct comparison with the campaign database (Hafner et al., 2012) is impossible due the different methodology. In addition to a different methodology being used in the survey and a time interval of six years, other developments that might impact the generation of food waste also intervened between the two studies, such as:

- activities by industry or the private sector (e.g. food-sharing initiative);

- educational measures by the state (e.g. BMEL's "Too good for the bin" campaign);

- rising expenditure in the catering services market (Mueller, 2018);

- rising share of ready-to-eat meals consumed at home (BMEL, 2017b); and

- a decreasing share of people that regularly cook at home (BMEL, 2017b).

There is therefore a need to also look at the respective underlying conditions and their effects when it comes to interpreting any changes in quantities.

As regards the proposed focal areas of target group-specific measures, it should be pointed out that both a host of online-based recipe databases and conventionally printed cookery books are now available. Some online databases enable recipes to be calibrated for the desired number of persons[14] or allow a targeted search to be made for tasty recipes that can be made with leftover ingredients[15]. The current trend towards cookery books for leftovers has compelled even celebrity chefs to deal with this subject (e.g. Tom Riederer, 2011). Ideas for recipes on how to cook with leftovers by Sarah Wiener or Johann Lafer, for example, are also included in the "Too good for the bin" app. Providing additional funding for such measures therefore seems to be of minor importance.

5.2.2   Additional information potential of the results

The report drawn up by GfK SE contains initial analyses of the results of the diary survey with, in some cases, links to information derived from other GfK data. However, a well-founded statistical evaluation was neither commissioned nor carried out. It therefore follows that, for example, differences between groups of households, regions or food categories were assessed based only on impressions and not on statistical tests. Thus, it is impossible to say for certain whether these are real differences between groups (e.g. variance) and whether the results are statistically significant or not (whether they only occur randomly in the sample or also apply to the entire population).

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[14]   cf. www.kochbar.de

[15]   cf. www.gutekueche.at/rezepte/zutatenverwertung.htm

Neither are any statistical analyses such as standard deviation or minimum or maximum levels available as yet. This means that it is currently impossible to estimate the uncertainties in the values calculated.

To the extent that the primary data allow a more detailed regional localisation, further layers should be examined, e.g. rural versus urban regions, city centre versus outskirts in conurbations, major regional centres/medium-sized urban centres/small urban centres, single-family house/multiple-family dwelling/blocks of flats. Such an approach would be helpful in order to illustrate the effect of differences in the structural environment on possible options for action and actual behaviour of households. If the available data fail to allow this depth of analysis, consideration should be given to making corresponding changes in future surveys.

All in all, multivariate analysis would enable the links between different variables (e.g. age, place of residence, discarded products) to be examined. Such results permit a closer look at background circumstances and linkages that are useful for developing and implementing further measures.

In addition, the published final report on the GfK SE's diary survey does not analyse all the available findings; this means that the data still holds further potential for providing relevant information.

5.2.3   Recommendations for follow-up surveys

It is recommended to repeat the survey within a reasonable time period (e.g. 3-5 years). The findings should be used to build up a time series for household food waste level. However, it is important to note that minor weaknesses in the questions should be rectified in order to prevent future misunderstandings in the use of terms. These adaptations should, however, be implemented in a sufficiently sensitive manner to ensure that results remain comparable and trends can be identified.

It is recommended to conduct a sound statistical analysis of survey results in any follow-up survey in order to identify statistically valid differences (variance, significance), for instance between regions (different settlement and disposal structures), seasonal peaks or different characteristics of households (such as education, age, type of household, level of income, cooking habits). Such results could play an important part in adapting awareness-building measures in a targeted manner or in developing viable alternative courses of action.

A possible follow-up survey should enable discarded food to be allocated to predefined categories more precisely. A certain imprecision was particularly noted with regard to allocating discarded food to "loose/open". In this study, it was possible to select this category for food that had been taken out of its packaging prior to disposal. Given that there were also categories

entitled "opened packaging" and "unopened packaging", it is not possible to interpret the results using these categories.

In order to obtain answers on the effect of specific prevention measures taken by the public authorities, these measures could be included in the questionnaire accordingly. It would then be possible, tailored to the location of the household being questioned, to also take regional activities into account and to ascertain the actual impact on daily routines. In view of the fact that questions concerning food waste have evidently also been posed by other panel studies, it would be advisable to coordinate the different surveys (e.g. with respect to the usage of terms, coverage of different aspects, and comparability).

5.2.4   Integration of the study into long-term reporting and monitoring

The available results shed light, inter alia, on the quantities (amounts) and the composition of food waste in German households. Using a methodical approach (coverage method), the waste levels reported by households were corrected, based on a comparison with the food volume purchased, and then extrapolated for Germany as a whole. This method was, for the first time, applied to this issue in Germany and has yielded valuable insights. It is not, however, possible to directly compare these results with findings from earlier surveys on the waste levels and composition of food waste in German households (cf. Hafner et al., 2012; Cofresco, 2011) (see also "correction" of the slogan used in the "Too good for the bin" campaign), even if the subject covered by the survey was ostensibly the same. The difference between the methodological approaches used (e.g. diary survey, evaluation of secondary statistics) is too great. As has been stressed a number of times, the levels recorded in the diary study constitute a lower threshold.

As already explained in chapter 3.2., it is necessary from a scientific perspective to ask whether the aim of a household survey should be an absolute survey of quantities or whether preference should be given primarily to qualitative information. The survey of amounts of discarded food waste is less useful for extrapolating the overall amount of household food waste throughout the country than for ascertaining the relevance of the disposal routes used and product groups concerned in each case. In addition to this, the diary study fulfils an important function in surveying different modes of conduct within differently-structured households. In the context of a monitoring system (i.e. a repeated, comparable survey), household responses to interactions can also be examined and, if necessary, re-adjusted. A shift from passive measurements of the respective existing situation to pro-active control would thus be possible. Furthermore, a more targeted consideration of details would allow conclusions to be drawn as to the impact of food waste on other areas of sustainability. A simple reporting system that only comprises surveys on the total amount differs substantially from a monitoring system, given that the latter, based on the existing situation, provides feedback on active interactions which enables the process to be steered.

In the course of the planned introduction of a national indicator of food waste, similar data are to be gathered along the entire value-added chain, albeit using other methods to collect data. Calculations concerning the national indicator should take all sectors involved into account and place food waste in a national context. Merely surveying food waste amounts within one sector (in this case households) could disguise quantities of waste along the value-added chain, ranging from agricultural primary production to processing and trade, that cannot be assigned to a specific sector and consequently do not appear in any statistics. Ideally, while sectoral calculations supplement a holistic view of the entire value-added chain with detailed information, they cannot replace such holistic views at (inter-)national level (cf. Xue et al., 2017). The FAO's supply balance sheets are a well-known example of consistent, multisector surveys that will in future also be used to calculate the Global Food Loss Index (Fabi, 2017). Methods such as the macroeconomic mass balances (cf. Liu, 2017) or input-output models (cf. Schmidt, 2017) are also, at international level, being suggested for national monitoring of food waste.

It is to be expected that the results of an isolated sectoral study and a cross-sectoral analysis will always differ due to the different methods used and the differing quality of data (e.g. primary data versus secondary data, estimation errors, level of detail, social desirability, ...). This difference is caused by the methodology and, due to limited resources in terms of finance, time and personnel, cannot be prevented. However, these deviations should, in due course, be able to be better estimated or explained by supplementary additional surveys.

Examining the absolute figures should not deflect attention from the insight that too many foodstuffs are being thrown away inadvertently and that there is an urgent need to improve this situation.

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Annex

Annex

Annex 1:   Structure and contents of the diaries

Abbreviation	Long text	Contents
TNnr	Number of participant	anonymous 6-digit number
Year	Survey year	2016 / 2017
Month	Survey month	1 – 12
Day	Survey day	1 – 31
Wave	Survey group	1 - 12
Type	Type of food	e.g. meat/poultry (see below)
Why_1	Reason for disposal – main reason	e.g. cooked too much, inedible (see below)
Why_2	Reason for disposal – second reason	Mostly not specified
Condition	Packaging	e.g. loose/open (see below)
Where	Route of disposal:	e.g. organic waste bin (see below)
Quantity	Amount in grams	Estimated mass
Age	Age of the head of household	< 40 / 40-59 / >59 years
Size of household	size of household	1- / 2- / multi-person household
School education	highest completed level of education	e.g. university entrance qualification certificate
Life cycle	Family situation	e.g. young with children (see below)
Region	Macroregion in Germany	North, East, Centre, South (see below)

Type of food: other berries, meat / poultry, coffee / tea leftovers (e.g. coffee grounds, tea bags), tomatoes (vine tomatoes, beef tomatoes), onions, strawberries, avocado, mini tomatoes (e.g. cherry tomatoes), courgettes, other bakery products, apricots, peppers, eggs, salad, side dishes (e.g. vegetables, potatoes, noodles), bread, baguette (not open), etc., carrots, turnips, pasta / rice dishes, etc., savoury spreads, nectarines, rolls, pretzels, etc., other. Milk products (e.g. yoghurt, curd...), cucumbers, slicing cucumbers, milk, biscuits, waffles, rusks, cookies, other ready-made meals / frozen foods, sausages, pineapples, apples, cheese, potatoes, bananas, grapes, edible fats / oils, other fresh fruit, baby food, infant food, cereal products (e.g. noodles, rice), other prepared meals, sandwiches / bread slices, alcoholic beverages (e.g. beer, wine, sparkling wine, spirits), other main courses, pizzas, pulses (peas, lentils, beans), breakfast cereals, etc. (e.g. muesli, cornflakes), sweet spreads (e.g. jam, honey, chocolate cream), plums, other vegetables, aubergines, peaches, pumpkin, cabbage vegetables (e.g. white cabbage, savoy cabbage, broccoli), mushrooms, olives, kohlrabi, pears, lemons, radishes, bakery products /

cakes, prepared salads (vegetables, fruit), mangoes, coffee, tea in liquid form, fish, meat dishes / fish dishes, herbs, kiwi, other melons, limes, pickled cucumbers, ice cream, watermelons, sweets (e.g. chocolate, confectionery, fruit gums), snacks (e.g. chips, salt sticks), ketchup / mayo / mustard and the like, radish, garlic, desserts, juice, lemonade, cola drinks, mineral water, corn, mandarins, clementines, nuts, cooked sauces/pastes, oranges, other vegetables/fruits in preserves, raspberries, other foodstuffs, ready-made soups/starters, spices, celery, dips/sauces, ready-made pizzas, baguettes, onion cakes, prepared muesli/cornflakes and the like, cabbage vegetables (e.g. sauerkraut, red cabbage), butter, asparagus, baking powder, recipe mixes, pudding powder, sauce binders, delicatessen salads (ready-made potato salads, cabbage salads etc.), frozen fruit, vegetables, cherries.

Why: spoiled, went off, bones / fishbones / rim of fat / skin etc., tea bags / leftover tea leaves, coffee grounds, fruit and vegetable bowls / seeds etc., too much has been cooked / prepared, package too big, not the whole quantity is needed, visually unappetizing / no longer tasty / \old\, best before date exceeded, too much was bought due to poor planning, wrong product has unintentionally been bought, bought too much for other reasons, does not taste good, coffee pads, unusable for other reasons, other, put too much on the plate, overcooked, burnt, salted, spilled, bought too big pack, because small packs are too expensive, not specified, wrong storage, accident (e.g. special offers only for larger packs or if several packs are purchased.

Condition: in opened packaging, loose / open/ leftovers from cooking / preparation (e.g. fruit peels, bones), prepared / cooked, in unopened packaging, deep-frozen

Where does the waste end up: compost, residual waste, organic waste bin, toilet /drain, used as animal feed, other.

School education: University graduate, university entrance qualification certificate / specialised technical college or full-time vocational school, intermediate school leaving certificate / secondary general school.

Life cycle: Young singles, older families without child /head of household working, single senior citizens, younger families with small children, younger families with school children, older families without child /head of household not working, middle-aged families without children, young families/couples without children, older families with children, families with teenage child.

Regions North, Centre, South and East.

THÜNEN