HelloFresh Global Food Waste Study | March 2020

German Country Report

Outline Report on German Dataset

Melanie Speck, Felix Buchborn, Sebastian Schuster, Anne Caplan, Mariam Nikravech[1], Manuel Bickel, Esra Keskin, Paul Suski

Assisted by Nina Langen[1], Erica Van Herpen[2], Tobias Engelmann[3], Shima Barakat[4]

[1] Institute of Vocational Education and Work Studies, Technische Universität Berlin, Marchstraße 23, 10587, Berlin, Germany

[2] Marketing and Consumer Behaviour, Wageningen University & Research, Hollandseweg 1, 6706KN Wageningen, Netherlands

[3] iSuN - Institute of Sustainable Nutrition and Food Production, FH Münster – University of Applied Sciences, Corrensstrasse 25 48149, Münster, Germany

[4] Entrepreneurship Education Adviser, University of Cambridge, CB2 1AG, Cambridge, UK

Wuppertal Institut

Publishers:

Wuppertal Institut für Klima, Umwelt, Energie gGmbH
Döppersberg 19
42103 Wuppertal

www.wupperinst.org

Authors:

Dr. Melanie Speck
melanie.speck@wupperinst.org

Felix Buchborn
felix.buchborn@wupperinst.org

Dr. Anne Caplan
anne.caplan@wupperinst.org

Mariam Nikravech
mariam.nikravech@campus.tu-berlin.de

Sebastian Schuster
sebastian.schuster@wupperinst.org

Manuel Bickel
manuel.bickel@wupperinst.org

Esra Keskin
esra.keskin@wupperinst.org

Paul Suski
paul.suski@wupperinst.org

Assisted by:

Prof. Dr. Nina Langen
nina.langen@tu-berlin.de

Dr. Erica van Herpen
erica.vanherpen@wur.nl

Tobias Engelmann
tobias.engelmann@fh-muenster.de

Dr. Shima Barakat
sb679@cam.ac.uk

The study was carried out on behalf of:

HelloFresh SE & Co. KG, Saarbrücker Strasse 37a, 10405 Berlin

Contents

Abbreviations, Units and Symbols

Abbreviations

Fig.	Figure
GHG	Greenhouse Gases
WI	Wuppertal Institute for Climate, Environment and Energy

Units and symbols

HF	HelloFresh
$	US-Dollar
%	Percent
€	Euro
a	Annum/year
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide equivalents
h	Hour
kg	Kilogram
g	Grams
km	Kilometer
l	Liters
t	Metric ton

Tables

Figures

Introduction

Background

For some years now, an intensive discourse on food waste has been taking place at both national and international level (Speck et al. 2020, Lukas et al. 2015). The relevance of this debate is based, among other determinants, on the high ecological and economic impacts associated with food waste. Various aspects can be cited as key reasons for the high number of wasted including wrong food planning, incorrect or excessively long storage of ingredients, misunderstanding of the best-before date, individual purchasing behavior (weekly bulk vs. daily demand shopping, impulse and aspirational buying), oversized shopping baskets as well as a lack of overview of one's own stock due to overcrowded refrigerators and storage cabinets (Van Herpen & De Hooge (2019), Waskow 2018, Van Geffen et al. 2016). Consumer behavior and, for example, the provision of information for consumers offer possible starting points (Scherhaufer 2019) to address food waste (Langen & Burdick 2012). As part of the Sustainable Development Goal 12 its third target (12.3) seeks to "halve the global food waste at the retail and consumer levels and to reduce food losses along production and supply chains, including post-harvest losses" by 2030 per capita (European Commission). As for governments as well as for food companies SDG 12.3 defines a helpful action and target line moving towards reducing food loss and food waste. Setting targets generates ambition, which may lead to action in private households (Buhl et al. 2019). New services with a subscription-based e-commerce model such as HelloFresh address innovative approaches for intervening with end consumers, being able to focus on important topics such as food waste in new ways. By delivering the precise quantities of ingredients needed for cooking a specific dish/meal for dinner, the discarded food is expected to be lower compared to conventional cooking. Thus –while using HelloFresh – there might be a great potential for private households to reduce food waste in comparison to other forms of dinner. In 2019, Heard et al. compared grocery store meals with meal kits and found that grocery store meals' greenhouse gas emissions are 33 percent higher than meal kits' emissions (Heard et al. 2019). The present study aims to demonstrate how a service such as HelloFresh could prevent or minimize households' food waste in Europe and North America. The study also calculates the carbon footprint for food waste in the categories plate-/cooking-/preparation-/unused- and inedible leftovers.

Objectives

The following hypothesis guided the study:

- If households use HelloFresh services, less food waste will be produced at home than with a conventional dinner.

The Wuppertal Institute has conducted a quantitative, international study (6 country-specific markets: USA, Canada, UK, Germany, Belgium and the Netherlands), starting with the consumers of Hello Fresh's US market. Due to the large sample (compared to other nutrition studies)[5] the study presented gives a very good over-

[5] See (Langen: 2012), (Stefan, van Herpen et al.: 2012) and (Leverenz et al.: 2019).

view. Food waste studies, which are based on a comparative analysis at household level in more than one to two countries (such as Refresh 2015-2019), are very few and far between. However, there is no claim to representativeness of the entire country-specific population (among other things due to the non-stratified random sampling from the overall population but also due to the survey methodology which can exclude de facto certain type of respondents).

Study design

Methodology

As part of the present research project, a quantitative household survey was conducted on behalf of HelloFresh. This survey is based on the hypothesis mentioned above (Raithel 2008, Diekmann 2002). The empirical approach is characterized by the fact that the subject of the survey should be delimited as precisely as possible in terms of content, time and space (Atteslander 1993). This requirement for empirical social research could not be fully met, as this survey broke new scientific ground. It is striking that the study was carried out in six different countries and exclusively in households using HelloFresh meal kits. It must be assumed that the results are not representative for the whole national population.

Design of the questionnaire

During the period from October 2019 to March 2020 the study was planned, conducted and evaluated in close cooperation with HelloFresh. The study was launched on 4th of October 2019.

The Wuppertal Institute developed and designed a three-part questionnaire, which was reflected in a detailed expert dialogue with experts from TU Berlin, the Münster University of Applied Sciences, the University of Wageningen and the University of Cambridge on 28th of October. ReFED, the US-American non-profit partner of HelloFresh, contributed to the further development on the different ways of handling options of food leftovers and food waste.

The tripartite structure of the questionnaire can be explained by the fact that the respondents were first asked to fill in an introductory questionnaire in order to query general statements about eating habits and attitudes towards food waste and HelloFresh. Afterwards, participants received a so-called "daily questionnaire", in which they wrote down what was present at dinner as well as how much and what kind of leftovers (see different categories) were generated per day. This daily questioning was repeated every day over a period of 3 weeks, regardless of whether a dish from the HelloFresh box was present/cooked or not. At the end of the survey the participants were asked to fill in a feedback questionnaire by asking them again for some statements about food waste and HelloFresh.

After successful participation – means filling in the intro and feedback questionnaire as well as 5 daily questionnaires – the participants received a free HelloFresh meal box.

The customers were informed about the study and invited to apply via e-mail by HelloFresh. A prerequisite for the application was that participants owned a kitchen scale.[6] Qualified participants were randomly selected by means of a random number

[6] The requirement to use kitchen scales was aimed at achieving more accurate results and generating fewer deviations, e.g. by rough estimates of the participants. It was also intended to help participants as a mean of clear instruction and to work as a support for those who are not used to weight measurements (e.g. USA) in grams. Despite the mentioned advantages of this method, it can have a restrictive effect to people who were interested in the study but did not meet the requirements. The resulting participants might belong to customers of HelloFresh who might have a well-equipped kitchen in which they cook regularly, as well as people who might already have a conscious handling of food and leftovers who are already aware of avoiding food waste as good as possible.

generator. As an incentive, consumers received a free box for the study week as well as a free box as a thank you for their efforts after participating in the study.

Carrying out the study

The survey was designed in SurveyMonkey and was conducted online in the period from November 4th to December 5th, 2019 in the US[7] and from November 16th to December 16th 2019 in all other markets. Consumers involved in the study first completed an intro survey (10 minutes) on general eating habits and their everyday actions.

Daily surveys of two weeks followed, supported by an additional week as a buffer for later reporting (e.g. to allow participants to report even if they would not have been able to report during the period). During this phase, the consumers were asked to report after dinner for 7 days on their experiences with HelloFresh and after that for 7 days on their experiences during regular diet (without HelloFresh).[8]

The number of reports per household was not limited. The daily survey was designed for 15 minutes working time. To fill out the Daily Survey correctly, the HelloFresh consumers received the following information as well as detailed information on the different leftover categories.

"*To complete the daily survey, you will need to prepare a few things before and after dinner. Here's a checklist on what you'll need to do: Get your digital kitchen scale and smartphone ready to go. Weigh (in grams) the 4-5 following types of food waste/leftovers from dinner outlined below, making sure you've zeroed the scale to avoid counting the plate or bowl in the weight. Please be sure to put aside inedible waste, cooking leftovers, and preparation leftovers during/after cooking dinner. This includes any food that would be disposed of or otherwise saved for later. If you throw out food earlier in the day that you intended to use for dinner but do not eat, please try to remember to weigh this too."*

Finally, from November 20th to December 5th, 2019, for the US and from November 20th to December 16th, 2019 for the other markets, a feedback survey (10 minutes handling time) was put online asking consumers about their personal attitude towards food waste and possible changes during the study.

Evaluation of results

The datasets were generated via .xls and the evaluation of results is done via "R" and "stata" – two statistical reporting programs. We have also made some assumptions and carried out a data cleaning to identify outliers via Box-Whisker-Plots. Detailed information is displayed in chapter 6.

[7] Due to Thanksgiving, the study was conducted earlier in the United States.

[8] Since numerous requests from HelloFresh customers arose after the end of the daily survey period, the survey phase was extended by another week. This enabled participants to fulfil their conditions for receiving the free meal kit.

Definitions

The following section describes the operationalized concepts used for measurements.

Leftover Categories

With regards to Van Geffen et al. (2016) and van Herpen et al. (2016, 2020), food waste in private households is produced throughout various different stages. In order to measure the amounts of leftovers and the respective food waste at household level, five different categories of leftovers have been developed:

1. **Unused Food and old(er) Leftovers**: any food that participants had saved or intended to use for dinner but ended up throwing away that day. This includes food items that were bought (at the supermarket etc.) but that respondents did not end up consuming as well as past/older leftovers that were thrown out. It is important to clarify that unused food is not necessarily associated with dinner (and reported as dinner type) on the day of reporting. For this reason, statements in this regard must be treated with caution as there is not enough evidence that the indicated amount of unused food and the reported dinner type are related.
   Examples: spoiled ingredients that would have been used when cooking dinner, spoiled leftovers; any excess ingredients from over-purchasing that are not consumed.
2. **Preparation Leftovers:** food, which was intended to be prepared for dinner but which has not been fully used.
   Examples: half a bell pepper, half an onion, egg whites separated for a recipe.
3. **Cooking Leftovers:** food, which is prepared but not served on the plate (remains in the pan/pot/bowl).
   Examples: additional soup that is still in the pan, extra salad that is still in the mixing bowl, excess main dish intended for consumption the next day.
4. **Plate Leftovers:** food that remains on the plate uneaten.
   Examples: pizza crust, vegetables ignored by picky eaters, potatoes that participants would not eat.
5. **Inedible food items:** food that is not intended for consumption but was delivered with whole items.
   Examples: onion peels, bell pepper stems, pepper seeds etc. (without/excluding spoiled food).

Aggregated leftover categories

The following categories were exclusively developed for this report.[9] These are aggregated presentations based on the categories mentioned above. The respondents did not encounter these during the survey phase.

1. Total Leftovers: Sum of all leftover types (Preparation, Cooking and Plate Leftovers)

[9] Proposed and requested by HelloFresh.

2. Pure Dinner Food Waste: Sum of food waste originated from Preparation, Cooking and Plate Leftovers
3. Total Waste: Sum of all reported food waste amounts (including all leftover categories: food waste of Preparation, Cooking and Plate Leftovers, Unused Food and Inedible Food Items)
4. Total Edible Waste: Sum of all reported food waste amounts as mentioned for Total Waste, excluding Inedible Food Items.

Types of dinner

The focus of the study is on dinner as a comparable meal to HelloFresh.

Since dinner and its preparation itself can differ in numerous factors in different private households, it was necessary to adapt the questionnaire to these differences. For this purpose, seven different types of dinner have been introduced:

1. HelloFresh meal: This category describes a meal cooked from scratch with fresh ingredients provided by HelloFresh in the weekly meal kit.
2. Non-HelloFresh meal: This category is understood to be the conventional dinner, a meal cooked from scratch with fresh ingredients. The selection/creation of the recipe and the purchase of the food items used was done by the participants themselves (not an arranged meal kit by HelloFresh).
3. Semi-/fully-prepared meal: This category is similar to the category "Non-HelloFresh meal" as mentioned above however mainly consists of semi-prepared, ready-to-cook or fully prepared components e.g. frozen pizza, lasagne. As participants might add side dishes like salad it is essential to also ask for specifics on preparation and cooking leftovers as well as inedible food items.
4. Did not eat dinner at home tonight: This category is for occasions like restaurants etc.
5. Leftovers: This category refers to dinner that only consists of leftovers from previous meals without any additional preparation or cooking.
6. Delivery service/take-out: A meal from a delivery service, restaurant or take-out that is consumed at home.
   Did not eat dinner at all tonight: Addressing participants who did not prepare or eat anything on the day of the report. In case this option was chosen the survey ended immediately.

As shown in Table 1, all leftover categories are addressed for the dinner types *HelloFresh meals, non-HelloFresh meals* and *semi-/fully-prepared meals*. When respondents stated the remaining dinner types *did not eat dinner at home tonight, leftovers* and *delivery service/take-out* no questions on preparation and cooking leftovers as well as on inedible food items were asked *Did not eat dinner at all tonight* meant an immediate dropout for the day of reporting.

Table 1: Overview of the surveyed leftover categories with regard to the different dinner types.

Leftover Category/ Type of Dinner	Preparation Leftovers	Cooking Leftovers	Plate Leftovers	Inedible food items	Unused Food and old(er) Leftovers
HelloFresh meal	X	X	X	X	X
Non-HelloFresh meal	X	X	X	X	X
Semi-/fully-prepared meal	X	X	X	X	X
Did not eat dinner at home tonight			X		X
Leftovers			X		X
Delivery service/take-out			X		X
Did not eat dinner at all tonight					

Options for leftover handling

In order to learn more about the different ways of dealing with leftovers along the consumption stages, the following options of handling were presented. Country-specific requirements were taken into account and provided in each case:

1. fridge: storage of leftovers in fridge or cupboard for later consumption
2. freezer: storage of leftovers in freezer or cupboard for later consumption
3. trash: disposal in residual waste
4. sink: garbage disposal and disposal in sink drain
5. pets: leftovers fed to pets or other animals
6. compost: composting at home
7. community compost: composting centre in neighbourhood
8. municipal compost: composting on municipal level
9. curbside compost: curbside compost collection (US, CAN, UK)
10. gftbak: municipal compost (NLD, BE)
11. bio-bin: municipal compost (GER)
12. food bank: donation to food bank or charity
13. other: additional options, differing from the mentioned methods above

Food and product categories

With regards to van Herpen et al. (2016), the following food and product categories were introduced:

1. Fresh produce (fruits and vegetables)
2. Processed fruits and vegetables (e.g. from a jar, canned or frozen)
3. Pasta, rice, bread, beans, lentils, chickpeas and other cereals/grains (including wraps, couscous, etc.)
4. Fully prepared foods (frozen pizza, ready-to-cook lasagne etc.)
5. Semi-prepared food that is simple to prepare (ravioli, pre-made pizza dough etc.)

6. Meat (not including cold cuts, see below)
7. Meat alternative/replacement products (veggie burger, tofu etc.)
8. Fish
9. Eggs
10. Dairy products (milk, yoghurt, cheese)
11. Simple ingredients consisting of bread, cheese, cold cuts, spreads, etc.
12. Other

Overview: Number of reports in Germany

To gain as much insights as possible participants were free to report on as many dinners as they wished. This resulted in a different number of daily reports submitted per participant.

Table 2 shows the overall participation status (differentiated by the three types of survey: introductory, daily and feedback survey) before and after data cleaning. The row labelled as *SurveyMonkey* shows every report entered by participants, counted as soon as the first question was answered (aborted questionnaires included).

The second row *cleaned data* shows the respective data, which resulted after applying the data cleaning process as, described in detail in chapter Data Cleaning.

Table 2: Participation status (number of reports)

	Intro Survey	Daily Survey	Feedback Survey
SurveyMonkey	223	2084	186
Cleaned data	166	1951	166

Main results

This chapter provides an overview of the findings/results after the evaluation of the data, starting with an overall distribution of reported dinner types during the survey period. Next follows a detailed view on the different amounts of leftovers and their respective food waste, considering each leftover category primarily on an aggregated level and afterwards individually, differentiated between all households and single and two-person households. The following sections emphasize the way of leftover handling and the possible reasons for unprepared and prepared food being wasted in private households. The following section highlights customer perceptions in general as well as specific insights and experiences participants made during the study. Resource efficiency estimation in terms of GHG-emissions is made in section 4.

Reports on dinner types

What different types of dinner were reported?[10]

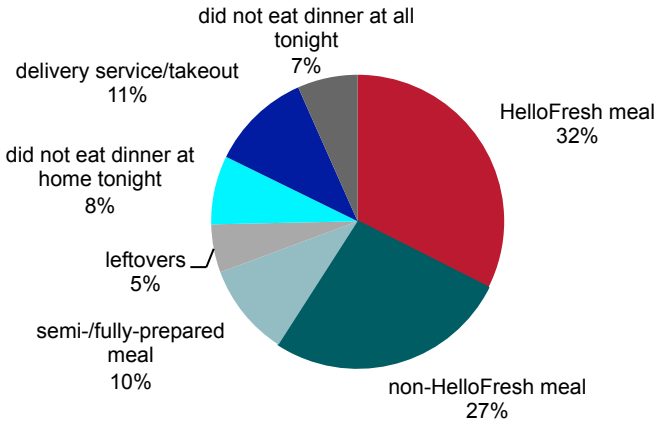

Figure 1: Shares of reports on specific dinner types of all households during the whole survey period (n=1938).

As Figure 1 shows, most reports (32 percent) were made about HelloFresh meals, followed by 27 percent non-HelloFresh meals and 11 percent delivery service/takeout. When looking at the other types of dinner, each type accounts for less than 10 percent of the total number of reports.

Leftovers and food waste

This section presents all results on quantified data of leftovers and food waste displayed for each stage of dinner preparation and consumption as well as in an aggregated state.

[10] For a better understanding of the presented types of dinner please check the chapter Definitions.

Table 3: Overview of percentage differences of the average leftover sums (in grams per capita and meal) of the presented dinner types according to the aggregated leftover categories.[11]

market	leftovers/food waste categories:	non-HelloFresh meal (grams)	HelloFresh meal (grams)	% less/more with HelloFresh meal compared to a non-HelloFresh meal	semi-/fully-prepared meal (grams)	% less/more with HelloFresh meal compared to a semi-/fully-prepared meal
GER	Total Leftovers	290,6	189,4	-35%	233,8	-19%
	Pure Dinner Food Waste	82,8	70,0	-15%	69,2	1%
	Total Waste	204,8	148,0	-28%	210,8	-30%
	Total edible Waste	158,8	109,6	-31%	189,5	-42%

Total leftovers and pure dinner food waste

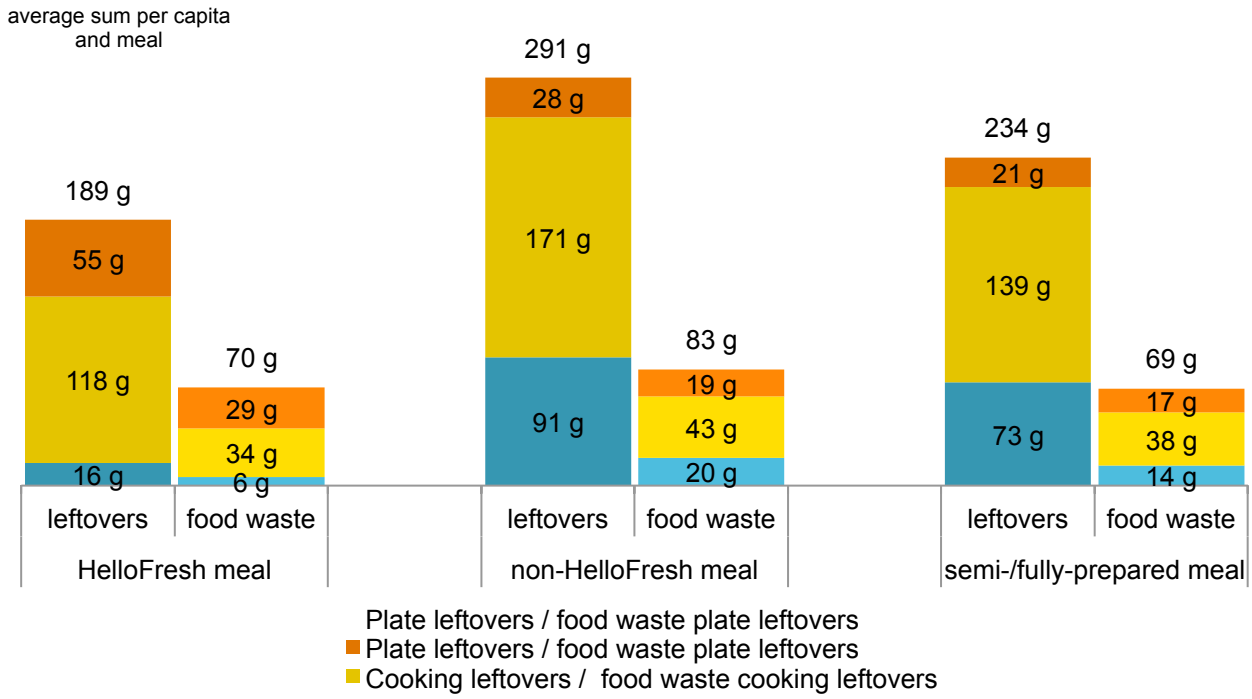

Figure 2: Average sums of preparation, cooking and plate leftovers (left column in each category) and respective food waste (right column in each category) of all households ($n_{preparation}$=95, $n_{cooking}$=155, n_{plate}=55).

Figure 2 indicates an aggregated overview of the average sums per capita and meal of leftovers and their respective food waste in the three leftover categories (preparation, cooking and plate leftovers). The indicated leftovers and food waste in grams are

[11] This table and its presentation of the displayed data follows HelloFresh's request. The average sums of each respective leftover category are added up. This is not the weighted overall average of each aggregated level.

grouped by three different dinner types: HelloFresh meal, non-HelloFresh meal and semi-/fully-prepared meal.[12]

In total the average amount of leftovers of Hello Fresh meals (189 grams) is 35 percent (102 grams) less compared to non-HelloFresh meals (291 grams) and 19 percent (45 grams) less than semi-/fully-prepared meals (234 grams).

While the amounts of leftovers differ immensely the average values of food waste between HelloFresh (70 grams), non-HelloFresh meals (83 grams) and semi-/fully-prepared meals (69 grams) are converging. This might be due to a different way of handling leftovers (more insights in the section Leftover handling).

Generally, the section of leftovers with the largest amounts as well as the largest resulting food waste among the three presented dinner types is the one of cooking leftovers. When comparing leftovers HelloFresh meals produce the the lowest range of leftovers (118 grams), about 31 percent less than non-HelloFresh meals (171 grams) and about 15 percent less than semi-/fully-prepared meals (139 grams).

Looking more into the resulting food waste within each dinner type, the image does not change: With food waste originated by cooking leftovers HelloFresh meals have the lowest range. HelloFresh meals are about 29 percent, compared to 25 percent resulting food waste of non-HelloFresh meals and 27 percent of semi-/fully-prepared meals.

The aggregated figure 2 in its individual components partly insists on significant differences. Please see the several components for more details.

[12] Please note: Other dinner types are not included in this section due to the fact that preparation and cooking leftovers occur when respondents prepare dinner and cook for themselves. Plate leftovers for all dinner types are presented in Figure 5 (chapter 1.1.1.5).

Preparation leftovers and food waste

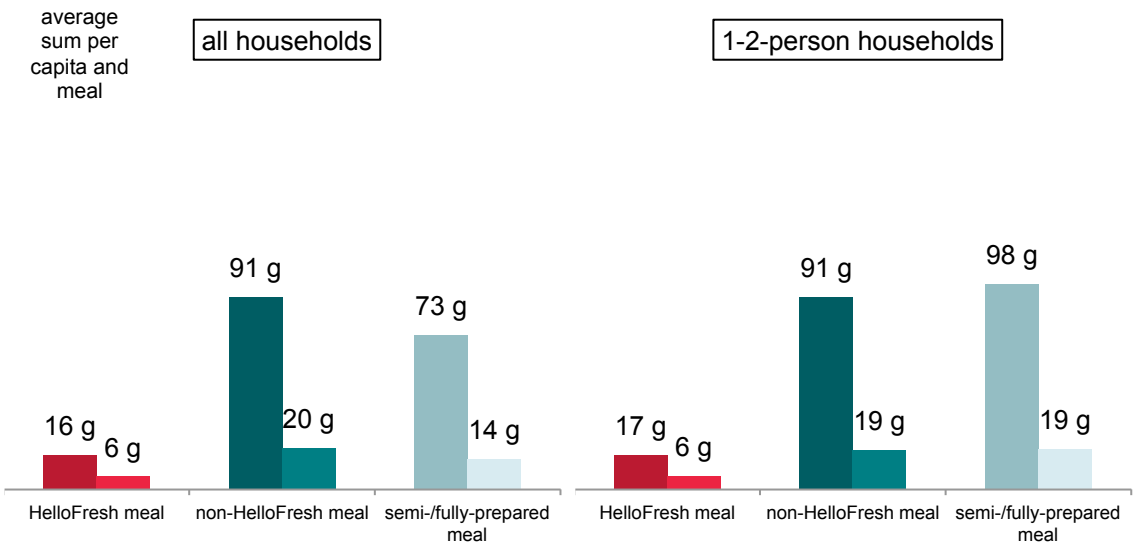

Figure 3: Average amount of preparation leftovers (left column in each category) and food waste (right column in each category) differentiated by dinner and household types (n=95).

Figure 3 presents besides the overall perspective of all households as well as of the single to two-person households.

In general preparation leftovers of HelloFresh meals (16 grams) are about 82 percent and the resulting food waste (6 grams) about 70 percent less compared to non-HelloFresh meals (91 grams and 20 grams). Comparing the resulting food waste, it can be ascertained that about 38 percent of HelloFresh preparation leftovers go to waste, while non-HelloFresh preparation leftovers generate an average food waste of 22 percent.

While semi-/fully-prepared meals usually do not require high amounts of additional ingredients, numbers are relatively high (73 grams leftovers and 14 grams food waste).

Note: Regarding the amounts of preparation leftovers and the resulting food waste of all households a highly significant difference can be found between the non-HelloFresh and HelloFresh meals (p: 0.000, 0.002).

When focusing on one and two-person households there is a significant difference between non-HelloFresh vs HelloFresh (p=0.000) and semi-/fully-prepared and HelloFresh meals (p=0.020). Regarding the respective food waste, we can identify a significant difference between HelloFresh and non-HelloFresh meals (p: 0.007).

Cooking leftovers and food waste

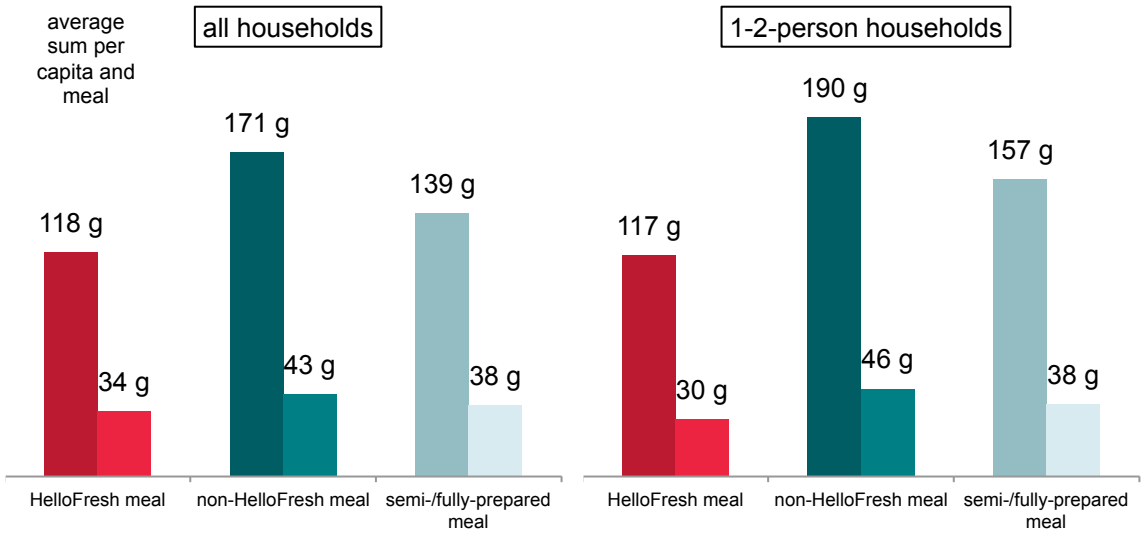

Figure 4: Average amount of cooking leftovers (left column in each category) and food waste (right column in each category) differentiated by dinner and household types (n=155).

As mentioned before reported cooking leftovers are relatively high compared to other types of leftovers (Figure 4). When looking at single and two-person households the average values of leftover and food waste of HelloFresh meals nearly don't change.

Leftover and resulting food waste average values of non-HelloFresh are higher (190 to 171 grams and 46 to 43 grams) compared to the overall data.

While average amount of food waste of HelloFresh meals (34 grams) is a few grams less compared to non-HelloFresh meals (43 grams) when looking at all households, the food waste of single to two-person households confirm this trend: the HelloFresh meal is at 30 grams while the non-HelloFresh meal food waste states 46 grams.

Note: There is a significant difference between non-HelloFresh meals and HelloFresh meals ($p=0.031$) regarding the amounts of cooking leftovers of single and two people households.

Plate leftovers and food waste

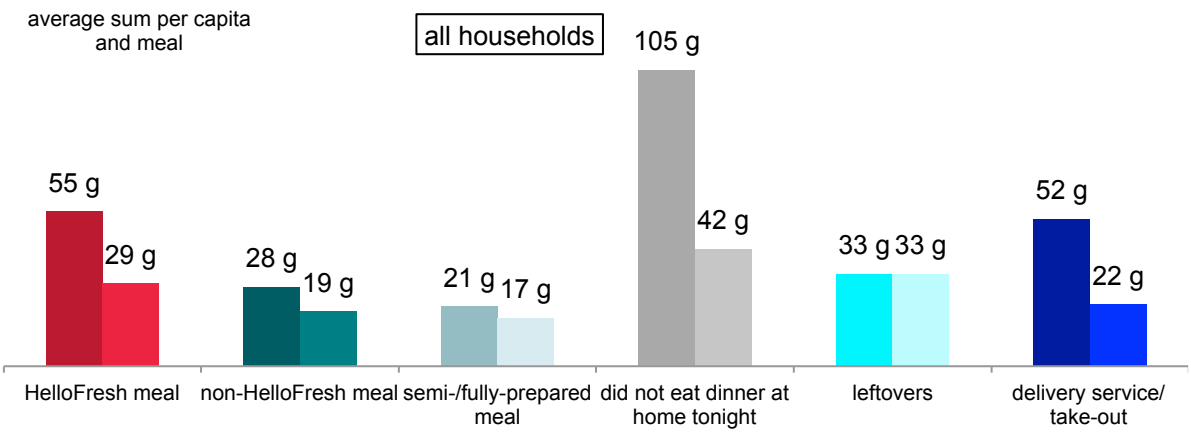

Figure 5: Average amount of plate leftovers (left column in each category) and food waste (right column in each category) of all household types, differentiated by dinner types (n=55).

While the average leftover amounts of plate leftovers among all dinner types differ immensely between 21 (semi-/fully-prepared meal) to 105 grams did not eat dinner at home tonight), the resulting food waste range is smaller (17 to 33 grams). Semi-/fully-prepared meals have on average the lowest reports on food waste from plate leftovers (17 grams), closely followed by non-HelloFresh meals (19 grams) (Figure 5).

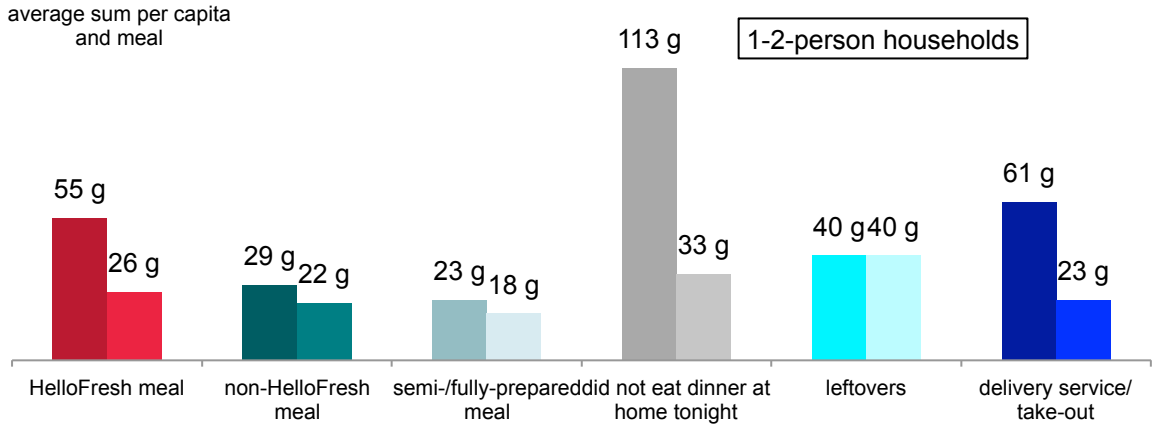

Figure 6: Average amount of plate leftovers (left column in each category) and food waste (right column in each category) of households with one or two persons, differentiated by dinner types.

Comparing the results of single and two-person households to the results of all households, a similar trend can be seen: Food waste average values are in a similar range (18 to 40 grams).

Looking at the leftovers, non-HelloFresh meals and semi-/fully-prepared meals indicate the lowest amounts (29 to 23 grams), while the dinner types not eating dinner at home (113 grams) and delivery service or take-out (61 grams) and also HelloFresh meals (55 grams) are much higher (Figure 6).

Note: Regarding the amounts of plate leftovers of all households a significant difference can be found in not eating dinner and home vs. HelloFresh meals (p. 0.043).

With regards to the amounts of resulting foodwaste of all households and single and two-person households no significant difference can be identified in all presented dinner types compared to HelloFresh meals.

Inedible food items

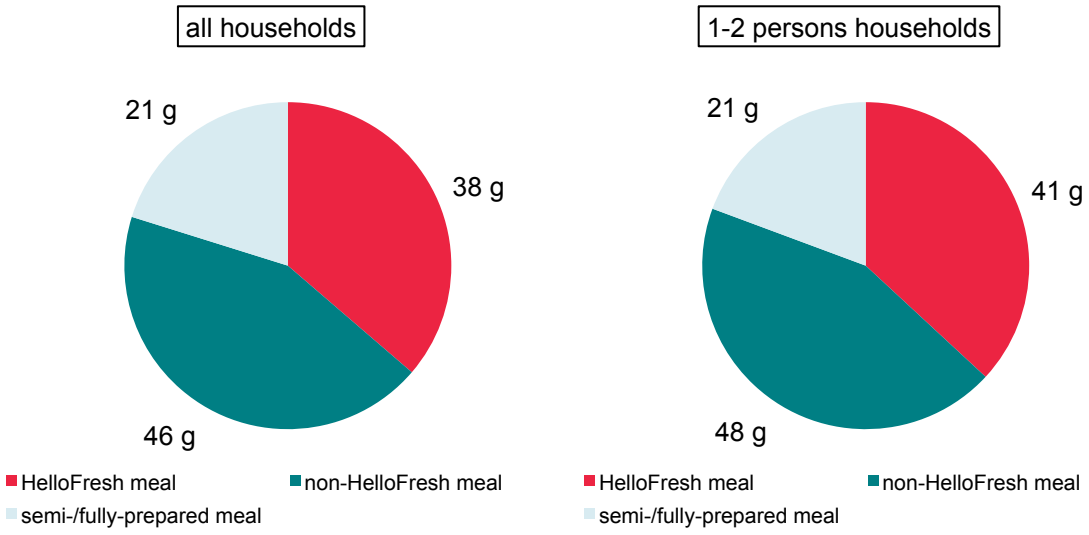

Figure 7: Average amount of inedible food items differentiated by dinner types for all households (n=409).

For inedible food items (Figure 7), the results among the three presented dinner types are similar between all and single to two-person households. While HelloFresh meals indicate about 38 grams and 41 grams of inedible leftovers, higher amounts occur if people eat non-HelloFresh meals (46 grams and 48 grams).

Looking at the single and two-person households the amount of inedible items is nearly the same, when people cook dinner from scratch and buy all ingredients by themselves, compared to the overall data. Not surprising is the result, that semi-/fully-prepared meals have the lowest amount of inedible leftovers for both household-types (21 grams).

Note: With regard to the amount of inedible food leftovers of all households and one- and two-person households, no significant difference to HelloFresh meals can be found for all presented types of dinner.

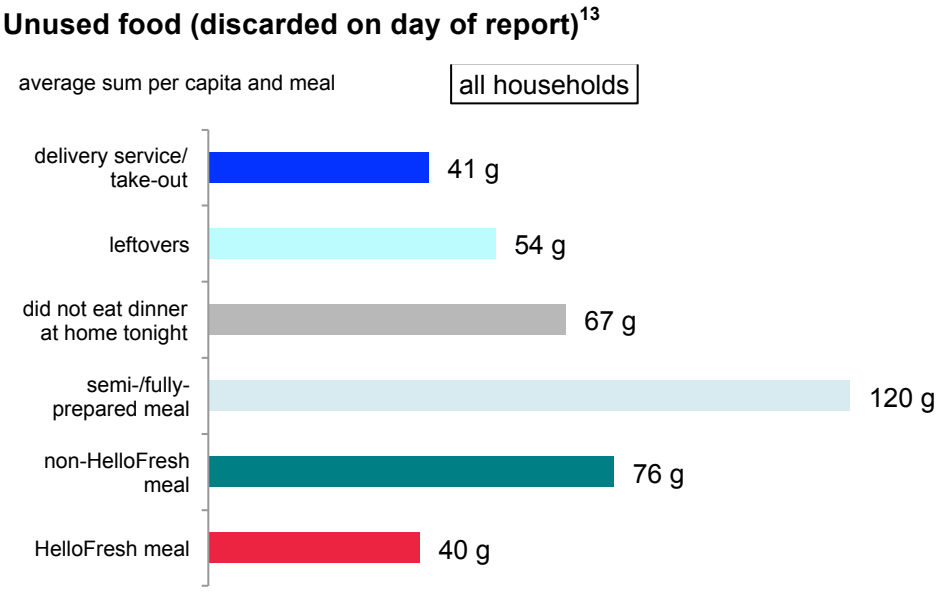

Figure 8: Average amount of purchased but unused food in all household types differentiated by dinner types (n=98).

With an average of 40 grams, participants reported lowest amounts of unused food items, when eating HelloFresh meals for dinner (Figure 8), closely followed by 41 grams of meals with delivery services/take-out.

If respondents had semi-/fully-prepared meals, they dispose an average amount of 120 grams of unused food, which is by far the highest amount reported.

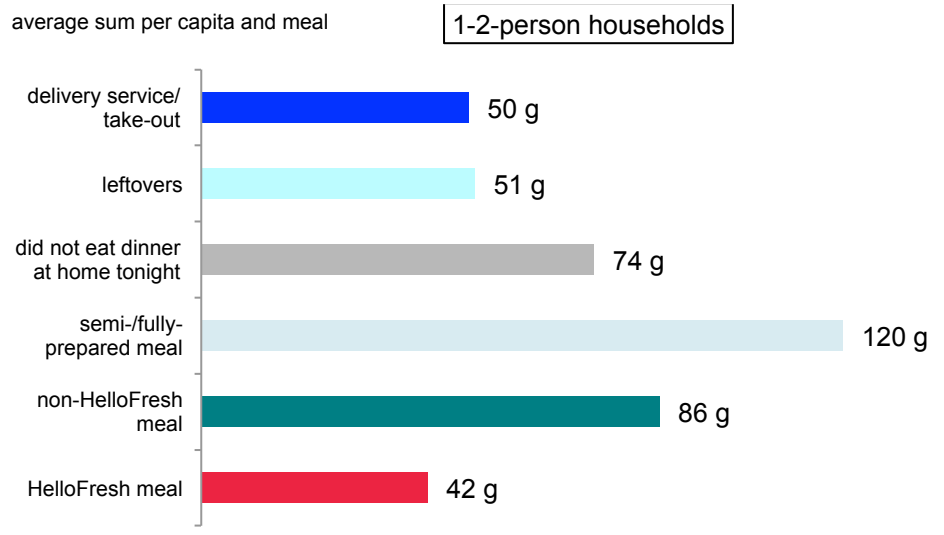

Figure 9: Average amount of purchased but unused food in household with one or two persons, differentiated by dinner types.

[13] The leftover category „Unused food" describes the amounts of food that were discarded on the respective reporting date. Respondents were asked to report on ingredients and food products that they had intentionally bought for dinner but did not consume (e.g. went bad/spoiled) in the end. Please check chapter Definitions for more information.

Looking at the same data filtered for one- and two-person households as shown in Figure 9, the same trends can be observed for all types of dinners. HelloFresh meals (42 grams) have again the lowest average on unused food.

With regard to the amount of unused food of all households and single and two-person households, a significant difference to HelloFresh meals can be found for semi-/fully-prepared meals ($p=0.004$, 0.011).

Unused HelloFresh ingredients

While about 75 percent (n=472) of the participants reported that they had used all ingredients provided in the HelloFresh meal kit ($n_{\text{HelloFresh meal}}=629$), about 15 percent (n=93) of the respondents stated that they had not used all of them.

8 percent provided more detailed information in terms of weight/quantities, resulting in an average amount of 38 grams per capita and meal (n=48).

Leftover handling

This section covers the multiple ways of handling of (accumulated) leftovers. The handling is displayed in the presented leftover categories, regarding the different stages of food preparation and consumption.[14]

Handling of all dinner leftovers

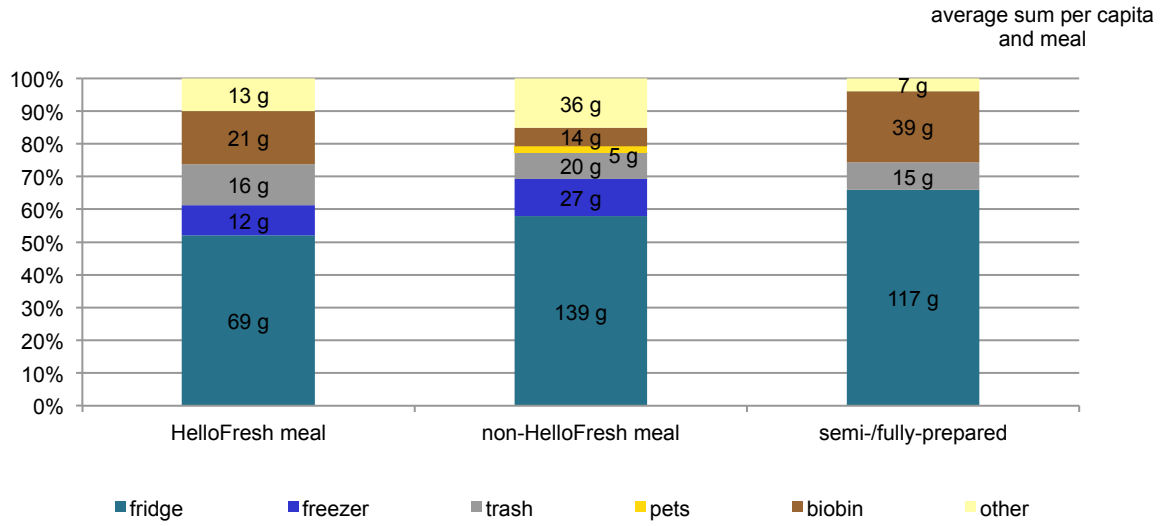

Figure 10: Handling of all dinner leftovers differentiated by handling options and dinner types, weighted (n=449).

As Figure 10 shows, the largest amount of dinner leftovers is stored in a fridge (52 to 66 percent) followed by disposal in the biobin (6 to 22 percent) and in the trash (8 to 12 percent). This trend can be observed in every stage of food preparation and consumption.

Handling of preparation leftovers

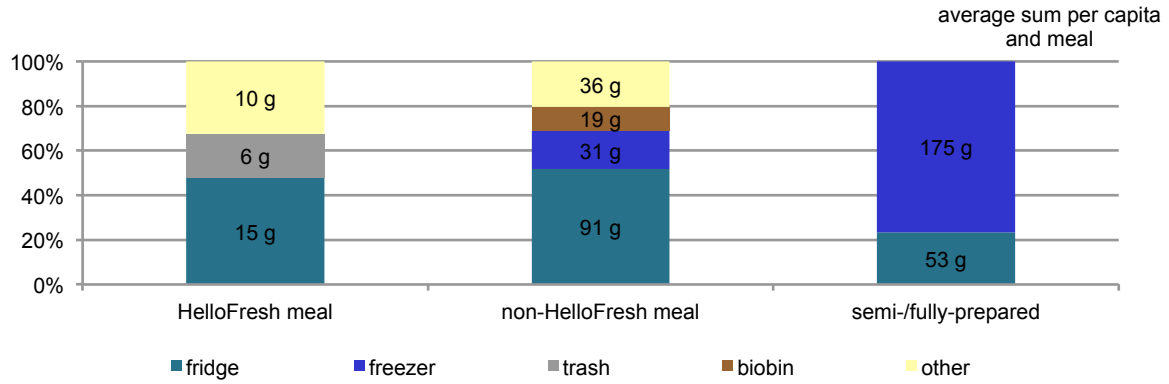

Figure 11: Handling of preparation leftovers differentiated by handling options and dinner types (n=120).

[14] Average leftover amounts below 5 grams are not considered. This applies to the whole section.

Preparation leftovers (Figure 11) of HelloFresh meals are storage in the fridge (48 percent) followed by other (33 percent) and disposal in the trash (19 percent). The leftovers of non-HelloFresh meals are stored in fridges (52 percent) followed by other (20 percent), storage in freezers (17 percent) and disposal in the biobin (11 percent). Leftovers of semi- or fully prepared meals are stored in freezers (77 percent) and fridges (23 percent).

Handling of cooking leftovers

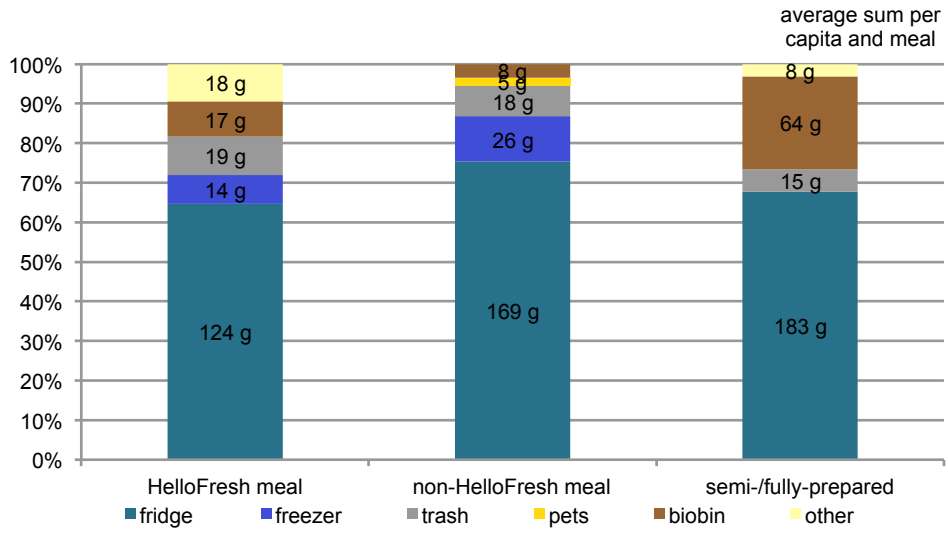

Figure 12: Handling of cooking leftovers differentiated by handling options and dinner types (n=250).

Regardless of stages of food preparation and consumption, major part of the cooking leftovers (Figure 12) is stored in the fridge (68 to 75 percent). 24 percent of cooking leftovers of semi- or fully prepared meals are disposed in the biobin.

Handling of plate leftovers

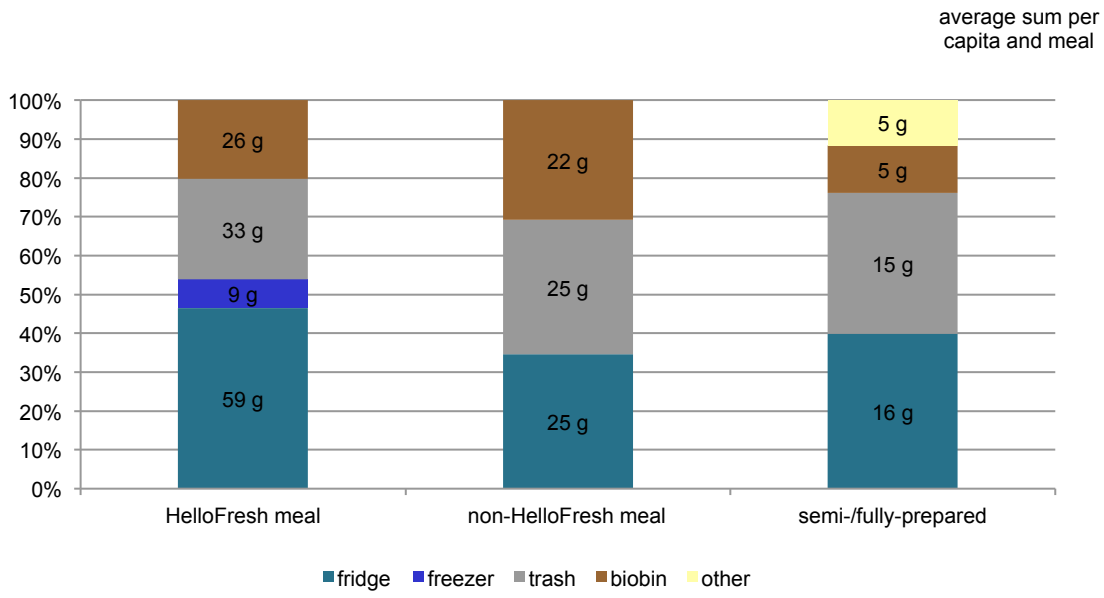

Figure 13: Handling of plate leftovers differentiated by handling options and dinner types (n=79).

As Figure 13 shows, most plate leftovers are stored in fridges (35 to 46 percent) followed by disposal in the trash (26 to 36 percent) and in the biobin (12 to 31 percent).

Reasons for food waste

This chapter illustrates possible reasons for food waste, on an aggregated stage for prepared and unprepared food.

Prepared food

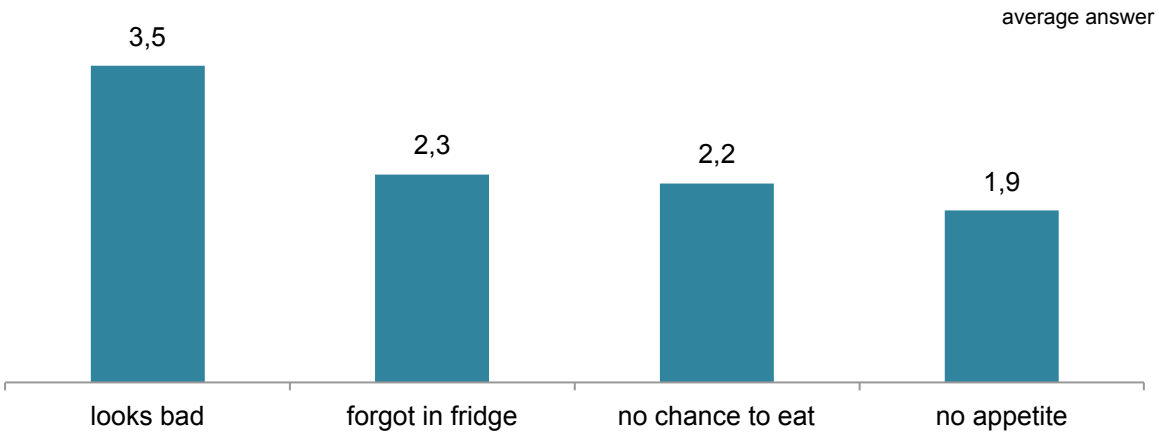

Figure 14: Reasons for prepared food being thrown away in private households. Reply options: 1=Does not apply, 2=Applies a little, 3=Mostly applies, 4=Fully applies (n=60).

For the majority of consumers, it mostly applies that they discard prepared food when it looks bad or seems to be spoiled. All of the other options are very close to each other (applies a little) and seem to be mainly due to time constraints in every-day life (forgot in fridge, no chance to eat). The category no appetite was less relevant (Figure 14).

Unprepared food

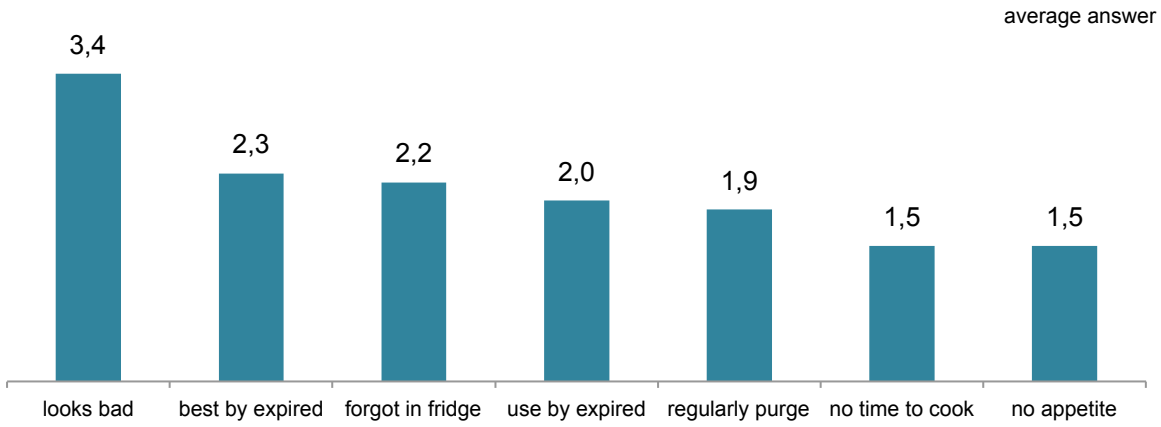

Figure 15: Reasons for unprepared food being thrown away in private households. Reply options: 1=Does not apply, 2=Applies a little, 3=Mostly applies, 4=Fully applies (n=130).

Prepared food is like, unprepared food only disposed of when it looks bad or seems to have gone bad (mostly applies). Although the use-before and best-before dates also play a role as well (applies a little), expired food is still consumed if it appears to be eatable.

General customer perceptions

This section reflects customer perceptions and opinions regarding HelloFresh and food waste.

Do respondents report less food waste when they believe that HelloFresh meals reduce the amount of food waste?

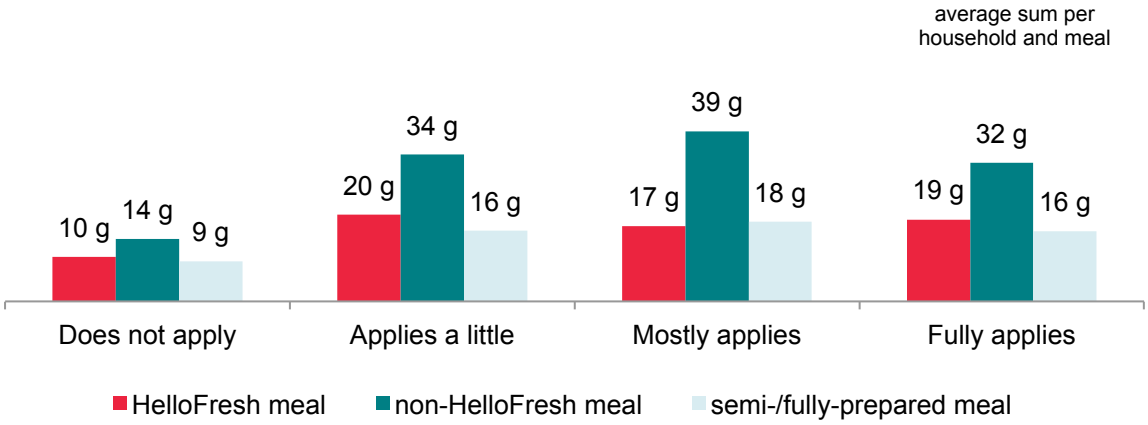

Figure 16: Average amount of total food waste compared to respondents opinion on whether HelloFresh meals make it easier to reduce food waste, differentiated by presented dinner types (n=556).

The highest amounts of food are reported for non-HelloFresh meals (39 grams), if household assume (mostly applies) that HelloFresh meals make it easier to reduce food waste. The lowest amounts of food waste for HelloFresh meals (10 grams) are reported by households for which there is no belief that HelloFresh meals facilitate the reduction of food waste. For all other categories of HelloFresh meals, relatively constant amounts of food waste (17-20 grams) apply regardless of whether consumers find that HelloFresh meals make it easier to reduce food waste or not.

Do respondents report less food waste when being satisfied with their personal food waste management?

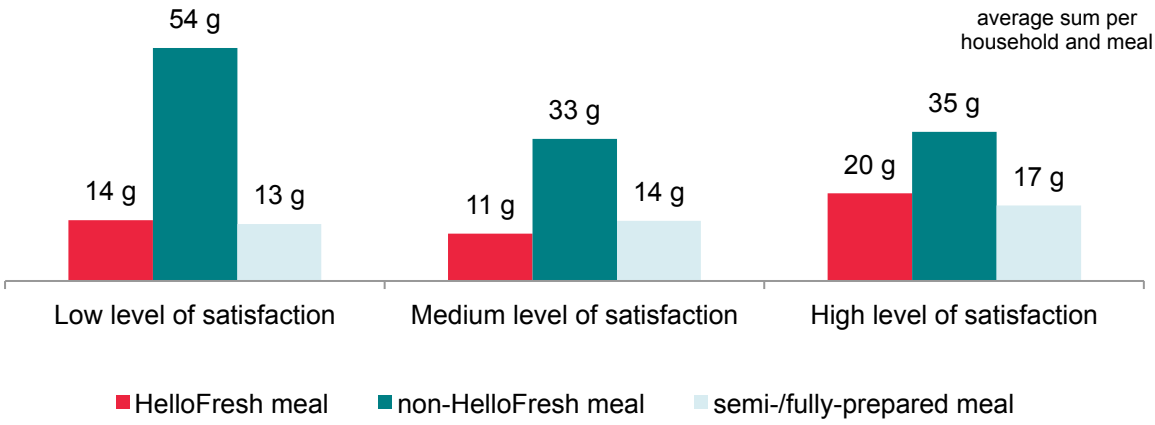

Figure 17: Average amount of total food waste sum compared to level of satisfaction with managing food waste, differentiated by presented dinner types (n=556).

Consumers who are very satisfied with their personal food waste management report more food waste for non-HelloFresh and semi-/fully-prepared meal types than those who are only moderately satisfied. So the more satisfied households are, not less food waste is reported except for non-HelloFresh meal participants who indicated a low level of satisfaction. For HelloFresh the food waste amounts are the highest in the high satisfaction level (Figure 17).

Do respondents report less food waste when they are used to ordering HelloFresh boxes?

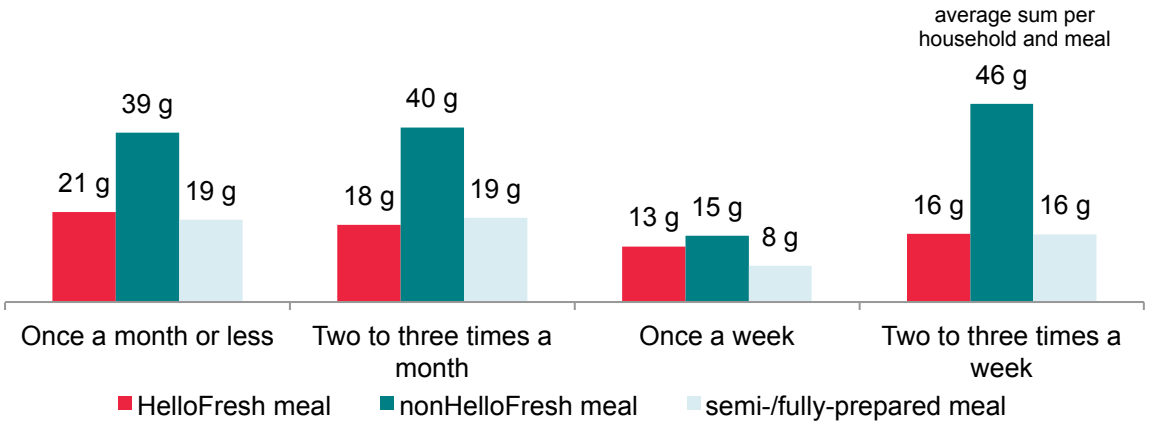

Figure 18: Average amount of total food waste sum compared to frequency of HelloFresh meal kit deliveries, differentiated by presented dinner types (n=566).

Households that order HelloFresh meals once a week report the lowest amounts of food waste quantities compared to the other ordering cycles (Figure 18). In fact, consumers who order HelloFresh once a

week report the lowest amounts of food waste for HelloFresh meals. It is noticeable that the food waste quantities of non-HelloFresh meals are much higher than for HelloFresh meals, especially when households order HelloFresh meal kits two to three times a week.

What is the average preparation time for dinner?

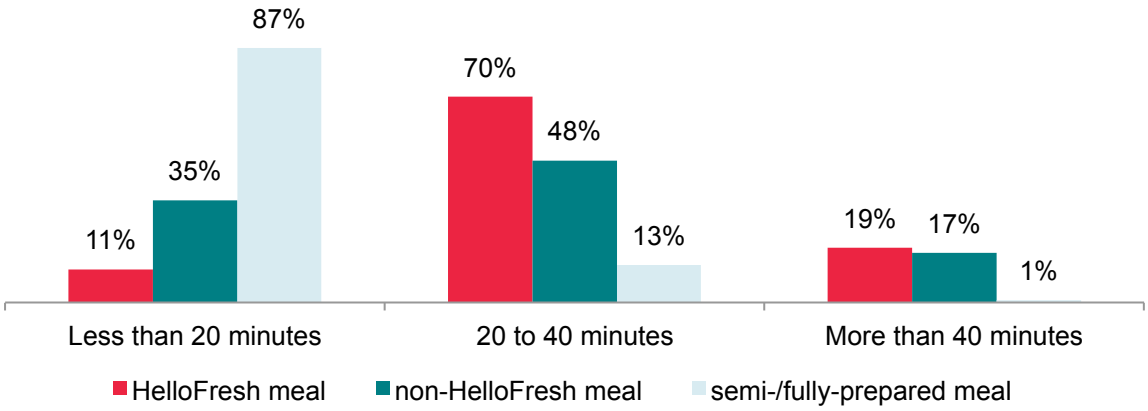

Figure 19: Preparation time for HelloFresh meals, non-HelloFresh meals and semi-/fully-prepared meals (n=1201).

The average preparation time for HelloFresh meals is mainly 20 to 40 minutes (70 percent), whereas the majority of semi-/fully-prepared meals need about 20 minutes for preparation. About 48 percent of the non-HelloFresh meals are indicated with a preparation time of 20 to 40 minutes, while 35 percent need less than 20 minutes to prepare and cook (Figure 19).

Do respondents think HelloFresh cares about food waste?

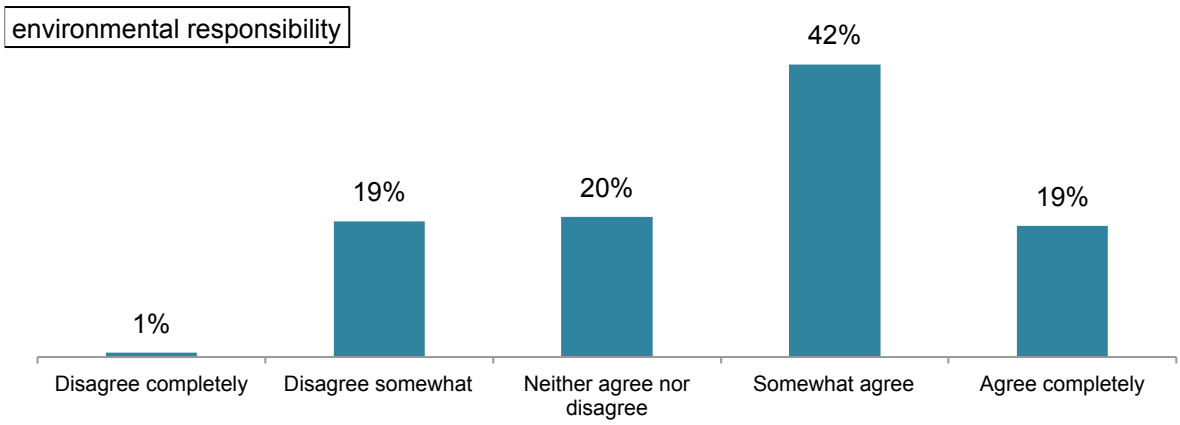

Figure 20: HelloFresh and environmental responsibility – opinion of consumers (n=166).

Figure 20 shows that 42 percent of the respondents somewhat agreed with the question whether HelloFresh is an environmentally responsible company. 20 percent neither agreed nor disagreed to this statement, while 19 percent agreed completely.

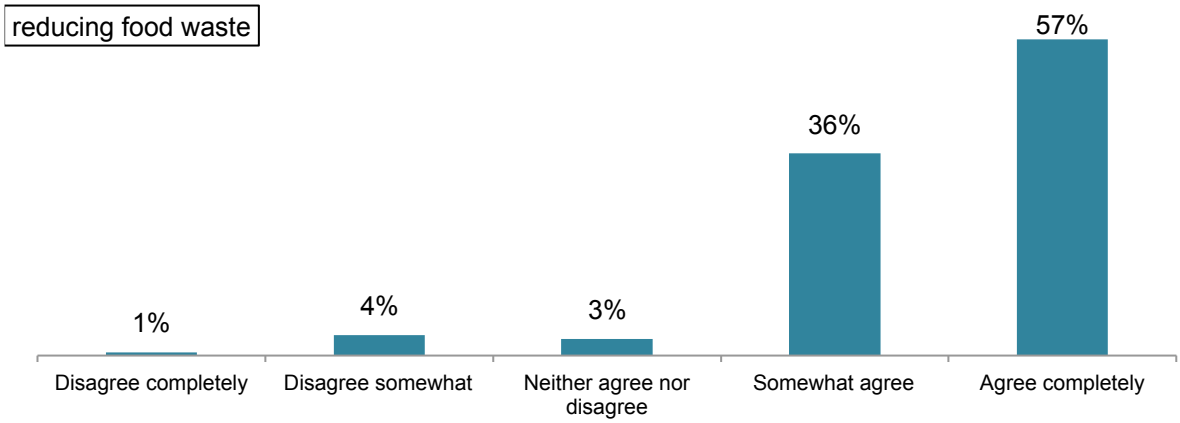

Figure 21: HelloFresh and food waste – opinion of consumers (n=166).

Around 93 percent agree with the statement that HelloFresh is doing a good job at reducing food waste (57 percent agree completely, 36 percent somewhat agree) (Figure 21).

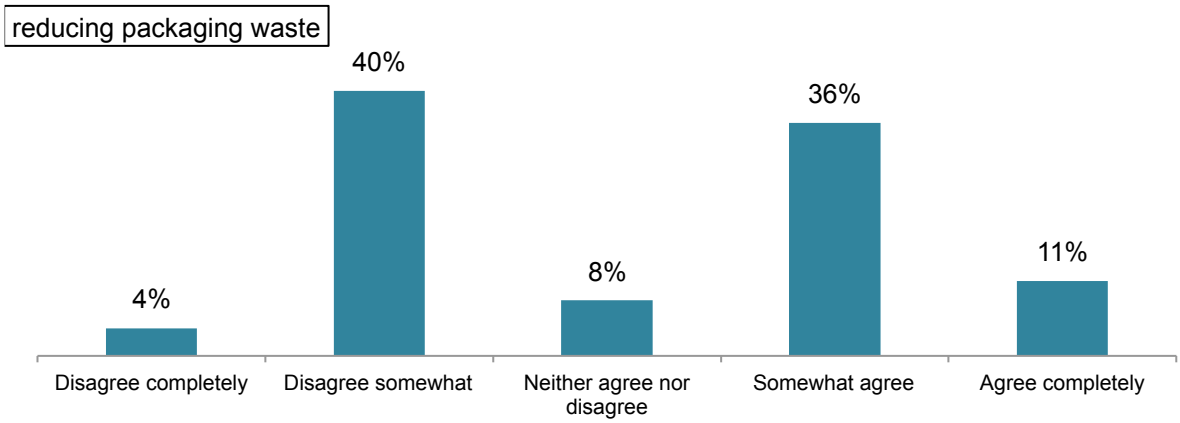

Figure 22: HelloFresh and packaging waste – opinion of consumers (n=166).

With regard to packaging waste, there is a relatively balanced relationship between those respondents who think that HelloFresh does a good job in reducing packaging waste (47 percent) and those respondents who think that HelloFresh does too little to reduce packaging waste (44 percent) (Figure 22).

As how healthy do the respondents rate HelloFresh dinners? As how healthy are the non-HelloFresh meals rated?

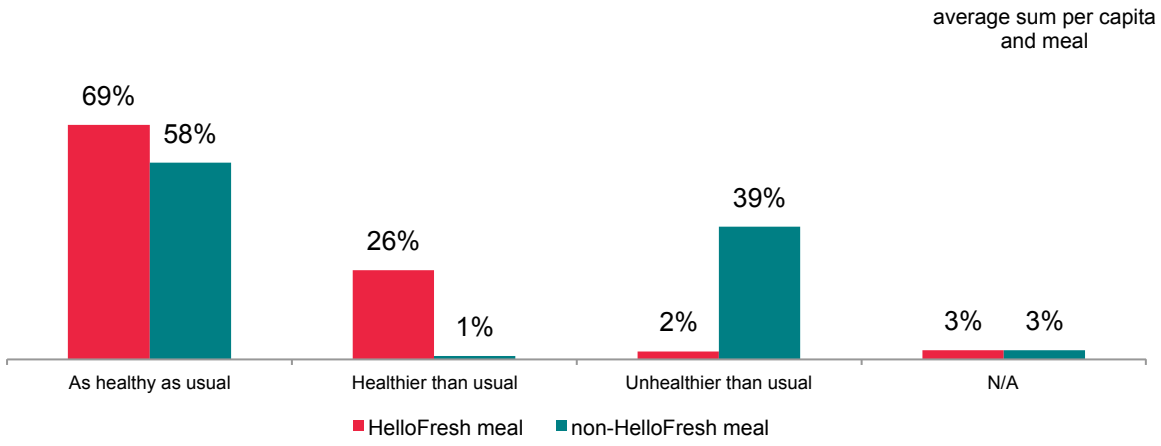

Figure 23: Rating of healthiness: HelloFresh vs. non-HelloFresh meals (n=155).

Most respondents rated their HelloFresh meal to be a dinner as healthy as usual (69 percent). About 26 percent considered it to be even healthier than usual while about 39 percent of the non-HelloFresh meals where rated to be unhealthier than usual (Figure 23).

What could HelloFresh do to help customers reduce their food waste?

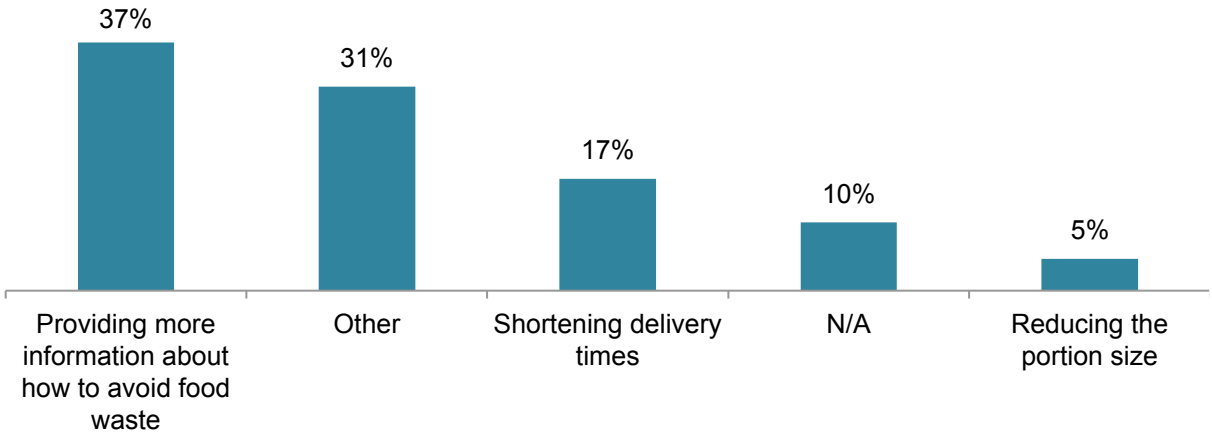

Figure 24: Possibilities of HelloFresh to support customers in reducing food waste (n=51).

About 37 percent of the respondents said that HelloFresh could provide more information about methods to avoid food waste in order to support their customers, followed by 31 percent who expressed their opinions individually (Figure 24).

When looking at individual responses, customers have awareness for food and think about leftovers. In general, they seem to have the impression that there are only small amounts of food waste. Some customers seem to think that the portion sizes are fine and should not be reduced. Several customers seem to see some potential of reducing packaging waste. Further, several seem to desire more options for personalized meals, since they do not use some of the ingredients, such as certain herbs.

Table 4 presents a selection of key statements (in German) on this question:

Table 4: Key statements of individual responses on „What could HelloFresh to do help you reduce food waste?“

Exemplary key statements of participants
Bei Hello Fresh ist die Menge an Lebensmitteln genau auf die Rezeptmenge angepasst, das klappt sonst beim Einkaufen nicht. Dafür fällt mehr Müll an.
Optionen bieten wie bsp. Chili, Knoblauch, besonders Koriander oder Kräuter abzubestellen, da man diese eventuell nicht mag oder Kräuter aus dem Garten zur Verfügung hat. Bei den Hello Fresh Gerichten bleibt manchmal eine sehr kleine Menge übrig, die sich nicht für ein Mittagessen/Abendessen lohnt und daher verkommt. Eine Vergrößerung oder Verkleinerung mancher Portionsgrößen würde Abhilfe schaffen.
Unterschiedliche Portionsgrößen, z.B Gerichte auswählbar für 1 oder 2 Personen
Teilweise bessere Kontrolle der verpackten Lebensmittel (häufiger faulige Stellen oder ähnliches)

Carbon Footprints

This chapter gives an overview of the CO_2-equivalents of leftovers in an aggregated state according the introduced category total leftovers.

The CO_2-equivalent of a product, in this case a food product, indicates the amount of greenhouse gas emissions emitted during the entire life cycle of the specific product. The global warming potential of different greenhouse gas emissions during the life cycle of an aliment is converted into CO_2-equivalents.

Table 5: Carbon Footprints of food and food products (without transportation), differentiated by aggregated leftover categories.

Leftover Category/ Type of Dinner	Total Leftovers ($\mathbf{kg_{CO_2-equivalent}}$ per capita and meal)
HelloFresh meal	0,49
Non-HelloFresh meal	0,78
Semi-/fully-prepared meal	0,55

As shown in Table 5 the carbon footprint of Total leftovers of HelloFresh meals (0,49 kg_{CO_2-eq}) is 36 percent less than Non-HelloFresh meals (0,78 kg_{CO_2-eq}) and 11 percent less than semi-/fully-prepared meals (0,55 kg_{CO_2-eq}).

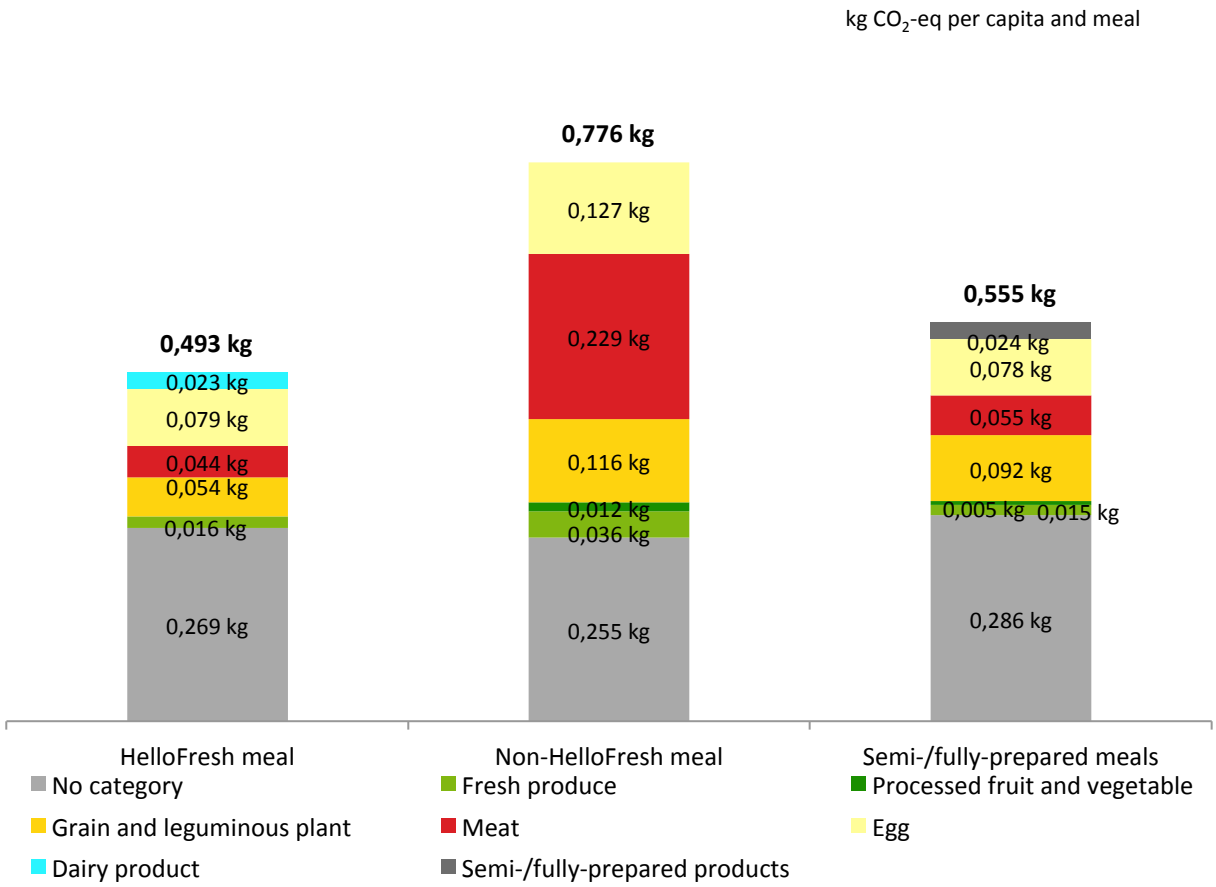

Figure 25: Total leftovers – average sums of the carbon footprints (kg CO_2-eq per capita and meal) by each food category, differentiated by the displayed dinner types (n=238).

Figure 25 shows the percentage shares of the carbon footprints by each food category for the pure dinner food waste, differentiated by the displayed dinner types. The carbon footprint of meat has the highest percentage in the total leftovers of non-HelloFresh meals (25 percent). Meat accounts for 7 percent of the carbon footprints of the HelloFresh meals and 10 percent of the semi-/fully-prepared meals.

A high percentage of meat can cause a higher total carbon footprint for the whole dinner.

It is important to note that the percentage of unnamed leftovers is for every dinner type nearly the half of the total carbon footprint. It is highest in HelloFresh meals (no category 62 percent), then in semi- or fully prepared meals (no category 52 percent) and in non-HelloFresh meals the lowest (no category 41 percent). This means that the percentage of remaining food wastes can still vary considerably from the values given.

Furthermore, only the HelloFresh meals (5 percent) included dairy products like cheese in the food waste.

Overall conclusion

Over the past years, food waste has become a political priority, a topic of increasing research interest and a topic of increasing interest in companies. A large amount of agricultural land is required to produce food that is never eaten, whilst the processes required to grow, process, transport, prepare food which leads to a high use of resources (Herpen et al. 2019, Speck et al. 2020). A better understanding of the drivers of household food waste and of the effectiveness of interventions in private households and in supply chains, is needed.

The HelloFresh Global Food waste study carried out by the Wuppertal Institute ties in with this scientific argument and addresses a very innovative research field. The currently very socially relevant topic of food waste mapping is addressed in a very sophisticated way. Households should not only determine their food waste, but also describe how they deal with leftovers. As different types of leftovers (leftovers that arise during cooking and are e.g. processed the next day were explicitly taken into account) were categorized in the project, so pioneering work has been done. In particular, the analysis of the reuse of different leftover types represents a relevant novelty value for research.

In the study we have put forward the hypothesis that if households use HelloFresh services, less food waste will be produced in the household than with a conventional dinner.

Consumers who are interested in reducing their personal food waste find a good way to achieve this in everyday life with the HelloFresh meal kits. With regard to the categories preparation leftovers and food waste as well as for cooking leftovers HelloFresh meals produce less average sums per capita than non-HelloFresh meals. In total the average amount of leftovers of Hello Fresh meals (189 grams) is 35 percent less than of non-HelloFresh meals (291 grams). In general preparation leftovers of HelloFresh meals (16 grams) are about 82 percent and the resulting food waste (6 grams) about 70 percent less compared to non-HelloFresh meals (91 grams and 20 grams). Cooking leftovers and food waste make up the largest share in this context, compared to preparation and plate leftovers and their respective food waste. It appears that single and two-person households on average generate more leftovers and food waste compared to the total amount of households.

With regard to the young, well-earning and educated target group of HelloFresh and the focus on easily consumable dinner types (50 percent in the sample) such as HelloFresh meals and delivery services/takeout, it can be assumed that the specific lifestyle of the target group is responsible for their higher food waste.

However, taking into account further findings from the scientific literature, it can be stated that food waste also occurs in families and households with larger numbers of members and must be considered.

Regarding the handling of leftovers, it can be observed that regardless of the stages of food preparation and consumption, major part of the dinner leftovers is stored in the fridge.

Significances for preparation-, cooking-. plate leftovers and food waste:

For preparation leftovers we could determine significance for the leftovers produced in all participating households in Germany. Non-HelloFresh meals produce with 91 grams 82 percent more leftovers than HelloFresh meals with 16 grams. We could also determine significance for the food waste produced in all participating households in Germany. Non-HelloFresh meals produce with 20 grams 70 percent more food waste than HelloFresh meals with 6 grams.

For preparation leftovers we could determine significance for the leftovers produced in participating 1-2 person households in Germany. Non-HelloFresh meals produce with 91 grams 81 percent more leftovers than HelloFresh meals with 17 grams and semi-/fully-prepared meals produce with 98 grams 83 percent more leftovers than HelloFresh meals with 17 grams. We found also significance for the food waste produced with preparation leftovers in participating 1-2 person households in Germany. Non-HelloFresh meals produce with 19 grams 68 percent more food waste than HelloFresh meals with 6 grams.

For cooking leftovers, we could determine significance for the leftovers produced in participating 1-2 person households in Germany. Non-HelloFresh meals produce with 190 grams 38 percent more leftovers than HelloFresh meals with 117 grams. For plate leftovers we could determine significance for the leftovers produced in participating 1-2 person households in Germany. Not eat dinner at home tonight produce with 113 grams 51 percent more leftovers than HelloFresh meals with 55 grams.

Considering the handling of leftovers, it can be observed that regardless of stages of food preparation and consumption, major part of the dinner leftovers are stored in the fridge.

Within the scope of the Global Food Waste Study it could be shown for Germany that HelloFresh offers a good alternative and can basically contribute to the reduction of food waste.

Recommendations for future research

Based on the results of the study, the following aspects can be derived for future research:

- Verification of results with a control group not related to HelloFresh. Here a more complex design is necessary.
- Explicit review of the category "unused food": The study has scientifically shown that this category cannot be observed on individual days, depending on the consumption habits. A long-term test (4 to 6 weeks) with the explicit aim of determining the shopping leftovers is necessary. A distinction should also be made here between households that use HelloFresh and those that do not use a delivery service.
- Further review of the leftover categories "preparation leftovers", “cooking leftovers” and "plate leftovers" in households without HelloFresh deliveries, in similar design to the *HelloFresh – Global Food Waste Study*.

- Review and further development of the dinner category “semi-/fully-prepared meals”: Respondents dealt with this category in different ways, as the reported answers show a great variation.
- In addition, the environmental aspects of the menus should be reviewed (menu check with regard to carbon and material footprint, Sustainable Level etc.; Lukas et al. 2015) to check the overall effect of HelloFresh deliveries in relation to national eating habits and to find out whether the HelloFresh menus always contribute to sustainable nutrition.
- Within the framework of further national research activities qualitative interviews could be conducted in HelloFresh households to better understand when and in which way HelloFresh is used and leftovers are being handled.

Limitations

Characteristics

1. Households that are HF consumers were involved in the study. . There was no control group.
2. Households had to apply for participation and were selected at random.
3. Households that own a kitchen scale participate in the study.
4. The number of reports per household was not limited, resulting in very different data situations (some households were very active, others less). The survey was open for a total of 3 weeks, resulting in a maximum of 21 questionnaires (if IDs reported every day). IDs that have filled in more than 21 questionnaires are removed from the evaluation, as they could manipulate the sample.
6. In some cases (most notably in the UK dataset) the date-time information could not be parsed. Therefore, the information of 65 cases is not available, because they only contained a 5-digit number (this is not a problem of a POSIXct format).
7. For some cases we do not have the time information. These cases do either include a time-information like 00:00:00 etc. or they don't contain a time information at all
8. Education and income levels are reported for every country, due to non-comparable differences in education and income levels (reporting per month, year).
9. We have some parsing errors, when extracting the numeric values out of the variables with leftover handling in percentages. The errors occur if participants typed in text like „All" or „Nothing". We don't transfer such cases into 0% or 100%, but handle them as response errors.
10. To calculate the leftover sums (variables that end with "_sum"), we extracted all numeric values from the corresponding leftover variables and summed them up. We can't take into account if people made information in tablespoons, ounces etc. We know that this is the case sometimes but we have to live with this kind of Errors.

Assumptions

1. We assume that a defined number of the leftovers that end up in the fridge or freezer will finally be thrown away (see data cleaning). This is calculated on the basis of question 15 of the feedback questionnaire (freezer/fridge cleaning). The respective information will be provided separately for each country.
2. The categories needed for resource efficiency calculation are based on the introduced food categories, presented in the daily survey. The first evaluation of the data showed relatively high lacks of reports (consumers did not report about the categories of food waste sufficiently). Therefore we will have to categorize the data considering our detailed evaluation and further

the normal allocation made from the recipes/dishes (70% plant-based ingredients etc.).

3. When calculating the leftover and respective food waste amounts of each category, only participants who had actually reported certain quantities of leftovers were considered.

Data Cleaning Procedure (Run Through)

Table 6: Overview Data Cleaning step-by-step.

Cleaning Step	What we do with which variables	Number of Observations that remain in the dataset
1. Raw Dataset		N = 13658
2. Parse numbers	Some people reported stuff like "100%" or "25 percent" in the percentage variables (column numbers: 23:34, 44:53, 57:65, 69:79, 83:94, 99:110, 145:154, 158:166, 170:179, 183:194, 199:210, 229:238, 244:255, 381:387, 390:396). That's why we parsed the numbers, to be able to transform the variables into numerics.	
3. Sum up percentages of leftover use	We sum the percent-points of the leftover use for each possible category. See the categories and the variables that were summed up below: Hf_ingr_not_used_perc_sum = sum 23:35 Hf_not_used_food_perc_sum = sum 44:54 Hf_prep_ined_leftovers_perc_sum = sum 57:66 Hf_prep_food_leftovers_perc_sum = sum 69:80 Hf_cooking_leftovers_perc_sum =	

	sum 83:95 Hf_plate_leftovers_perc_sum = sum 99:111 Nhf_not_used_food_perc_sum = sum 145:155 Nhf_prep_ined_leftovers_perc_sum = sum 158:167 Nhf_prep_food_leftovers_perc_sum = sum 170:180 Nhf_cooking_leftovers_perc_sum = sum 183:195 Nhf_plate_leftovers_perc_sum = sum 199:211 O_not_used_food_perc_sum = sum 229:239 O_plate_leftovers_perc_sum = sum 244:256	
4. Filter sum of percentages	The sum of the leftover use percentages is filtered. Every one of the in step 4 calculated variables has to be <= 100. 25 observations are removed from the dataset, because of this filtering.	N = 13633
5. Calculation of percentages that end up as food waste fridge/freezer	Based on question 15 of the feedback questionnaire, which tells us which percentage of the leftovers in the fridge or freezer are thrown away in the end, we known amount of leftovers that go to the fridge/freezer and end up as food waste. If a participant did not answer question 15, we use the country-specific mean and apply it to those persons. This mean values must not be cleaned because all submitted values are between 0-100, so that a valid mean can be calculated. Country specific means for leftovers	

	from the fridge that end up as foodwaste are: • USA: 36,1% • BE-DU: 31,3% • BE-FR: 32% • CA-EN: 28,5% • CA-FR: 39,9% • GER: 23,5% • NLD: 39,7% • UK: 20,9% ■ Country specific means for leftovers from the freezer that end up as foodwaste are: • USA: 44,9% • BE-DU: 48,8% • BE-FR: 48,6% • CA-EN: 36,2% • CA-FR: 42,4% • GER: 48,7% • NLD: 57,2% • UK: 52,6%	
6. Calculating the Sum of the leftover percentage points that are regarded as trash	Do calculate the amount of foodwaste, we calculate the sum of the percentage point of all leftover handling methods, that we consider as trash. Before that we calculate the percentage of fridge and freezer leftovers that end up as foodwaste. Please see the example calculation below. We do this for all leftover types. ■ First step: hf_cooking_leftovers_fridge_trash_percent = hf_cooking_leftovers_fridge * mean_trash_fridge_perc ■ hf_cooking_leftovers_freezer_trash_percent = hf_cooking_leftovers_freezer * mean_trash_freezer_perc	

	■ Second step: hf_cooking_leftovers_trash_percent_sum = hf_cooking_leftovers_trash + hf_cooking_leftovers_sink + hf_cooking_leftovers_pets + hf_cooking_leftovers_composted + hf_cooking_leftovers_community_compost + hf_cooking_leftovers_curbside + hf_cooking_leftovers_municipal_compost + hf_cooking_leftovers_gftbak + hf_cooking_leftovers_biobin + hf_cooking_leftovers_fridge_trash_percent + hf_cooking_leftovers_freezer_trash_percent ■ For further calculation we calculate new variables that indicate the percent sum of the amount of food that goes into the fridge/freezer and is not thrown away in the end. These variables end with "fridge_percent_sum" or "freezer_percent_sum". These variables are calculated as follows: ■ hf_prep_food_leftovers_fridge_percent_sum = hf_prep_food_leftovers_fridge * (1 - mean_trash_fridge_perc) ■ I will give you an example: If a person reports 280g of preparation leftovers and we know that this person put 50% of it into the fridge, we know that this amount of	

	leftovers is 140g (280 * 0,5 = 140). If we now know that this person throws 70% of his/her fridge leftovers into the trash, we know that the foodwaste is in the end 98g (140 * 0,7 = 98). The variable know indicates the amount of fridge leftovers that is not thrown away if we do the calculation above. Hf_prep_food_leftovers_fridge_percent_sum is 0,15 if we calculate 0,5 * (1 - 0,7). 280 * 0,15 = 42. 42g of fridge leftovers do not end up as food waste in the end.	
7. Systematic data cleaning and further calculations	At this step we clean the data systematically. We therefore take the reported leftover sums in grams and cut off each distribution at 3rd Quartile + 1 * IQR. We then calculate the amount of leftovers that go into the trash, fridge and freezer.	N = 12887
8. Calculate amounts per person	In the next step we calculate the leftover and foodwaste amounts per person. Therefore we clean the dataset and filter out all households that consist of < 1 & > 8 persons.	N = 11064
9. Relabelling factor values	In this step of data-cleaning is the relabelling of all factor values, so that each value corresponds to it's equivalent from the english questionnaire.	———
10. Filtering out Survey-IDs	The last step of data cleaning we remove all survey-IDs from the dataset that reported less than 3 or more than 21 daily reports. We do this to make sure that there are no reports in the dataset, that were submitted under wrong survey-ID and to get rid of participants who didn't have enough motivation.	N = 10885

Procedure for Significance Test

Leftovers and food waste

For the questions in the subsection Leftovers and Food Waste, the statistical significance of the average leftovers and food waste produced by the respondents during the study was computed by dinner type. The purpose of such analyse of significance was to confirm whether the amount in grams of leftovers and food waste was different when eating HelloFresh meal from eating a non HelloFresh Meal or other type of meal[15] and that is not due to mere hazard.[16] This analysis was repeated for all sorts of leftovers and food waste occurring during preparation, cooking, eating (plate leftovers) as well as unused food and inedible food, both in all households and in 1- to 2-person households in each country.

We thus test the differences between type of dinner against zero, posing the hypothesis that there is a difference in the mean food waste and leftovers amount which is not equal to zero (our Null Hypothesis being therefore H0: "There is no difference in leftovers/food waste between HelloFresh meals and Non-HelloFresh meals and other type of meals").

We conduct a one-way Analysis of Variance (ANOVA) to determine whether the mean of a dependent variable is the same in two or more (independent groups). This procedure was chosen since our dependent variable is continuous (amount of food waste and leftovers produced in grams) and the explanatory variable comprises more than two categories of meals (compared to paired t-test).

The following assumptions were made:

1. The differences between series (distribution of our dependent variable, here the difference in food waste amount) are approx. normally distributed. A histogram graphical analysis and Shapiro Wilk Test indicated that our dependent variable did not follow a normal distribution. Yet, we can assume that in case of large sample (N>30), this it is not problematic according to the Central Limit Theorem, allowing relaxing the normality assumption.
2. There are no significant outliers. The outliers were sorted out during the data cleaning process.
3. The observations are independents, meaning that there must be no relationship between the observations in each group. This assumption is the trickiest in this case at one could argued that our observations are repeated over the same households at different time and thus that repeated measurements ANOVA could be privileged. However, this implies a change in the structure of the data, which has consequences on the way the results

[15] For simplification, we will here refer to “other types of meal” which refers to semi- and fully prepared meal, meal from leftovers, meal from delivery service or takeout, dinner taken outside home and no dinner at all tonight.

16 Please note that due to the research design, no the inference can be claimed about the impact of HelloFresh on leftovers and food waste. We can for now only compare means and hint whether the observed difference in mean weight is only due to hazard or if the amount of food leftovers and food waste are different across dinner types.

are reported - HelloFresh wanted however to stick to the previous way of presenting data, at dinner level in each household. We decided thus to first conduct a one-way ANOVA. Repeated measures ANOVA could be envisioned at a later stage.

Below a summary of the steps conducted. This analysis was conducted in Stata 16.0 (StataCorp 2019).

Table 7: Overview analysis procedure step-by-step (leftovers and food waste).

Steps	What we do with which variables	Number of observations in the dataset
Reframing the independent variable	Convert the variable "type of dinner eaten" (dinner_kind) into a numerical categorical variable, instead of a string. Assigning a label to the variable and to its values.	N = 10885
Reframing the dependent variable plate leftovers and food waste per phase	For each phase (Preparation, Cooking, Dinner), generation of a single variable for (1) leftovers and (2) food waste as follows: [leftovercategory]_[leftover/fw]_weightpp plate_leftovers_weightpp plate_fw_weightpp prep_leftovers_weightpp prep_fw_weightpp cooking_leftovers_weightpp cooking_fw_weightpp prep_ined_weightpp unused_weightpp These new variables up the values of following the variables, respectively: hf_plate_leftovers_1_sum_pp nhf_plate_leftovers_1_sum_pp o_plate_leftovers_1_sum_pp; hf_plate_fw_1_sum_pp nhf_plate_fw_1_sum_pp o_plate_fw_1_sum_pp;	

	hf_cooking_leftovers_1_sum_pp nhf_cooking_leftovers_1_sum_pp; hf_cooking_fw_1_sum_pp nhf_cooking_fw_1_sum_pp; hf_prep_leftovers_1_sum_pp nhf_ prep_leftovers_1_sum_pp hf_prep_fw_1_sum_pp nhf_ prep_fw_1_sum_pp	
Reframing the country variable for Belgium and Canada.	Replace country code “BE” if country code = “BE-DU” | “BE-FR” Replace country code “CA” if country code = “CA-EN” | “CA-FR”	
Conduction of a one-way ANOVA for each leftover category, in each country, each type of leftovers, for all households and for 1- to 2-person households.	Regression of each variable [leftover category]_leftovers_weightpp on dinner_kind (factorial) (one-way ANOVA). Regression of each variable [leftover category]_fw_weightpp on dinner_kind (factorial). (One-way ANOVA). Analyse of the significance (p-value <0.05) of the F-model. Models which show an overall p-value<0.5 are considered for post hoc tests.	
Conduction of post hoc tests when the ANOVA shows significance	Any time the overall model is significant at the 5%-level (p-value<0.05), we conduct further post hoc test (Bonferroni Test) to identify, which pair of dinner types have a significant difference in terms of amount of leftovers or food waste produced in the overall model. We examine here again whether the differences in mean are significant at the 5%-level.	
Reporting of significance	The significance of the differences in food waste and leftovers weight between HelloFresh Meal compared to Non-HelloFresh meal or compared to other type of meals was reported, by household size and by leftover category and by country. For readability, the sample size as well as standards errors, F-value [F] and degrees of freedom [df] were not reported in the	

	main report, but are accessible in the Tables in Annex.	

General Customer Perceptions

Testing the significance of general customers perception was also considered, regarding their attitude towards HelloFresh's capacity to reduce the amount of food waste, their personal food waste management and the frequency of ordering HelloFresh. [17] A one-way ANOVA was performed at household level and could not show any significance in the difference of food waste across the level of attitude towards HelloFresh's capacity to reduce food waste (Fully applies, Mostly applies, Applies a little, Does not apply), level of satisfaction towards own food waste management (High level of satisfaction, medium level of satisfaction, low level of satisfaction) at household level, across all dinner types.

A two-way ANOVA tests was also conducted to take into consideration possible variation across dinner types and allowed to identify whether the interaction between dinner type and the above-mentioned variable could be associated with different amount of food waste.

None of these ANOVA led to identifying significant differences in total food waste produced per person across variable levels and dinner types.

The statistical model used in ANOVA is the following: $Y = X + \varepsilon$, where X is a combination of explanatory variables and ε is the error term, indicating a statistical dependency. ANOVA can only show whether a difference in means is statistically significant or not, it is to say whether the variation in the explanatory variable explains a significant part of the variation of the dependent variable. On the other hand, it should be clear that it cannot provide an explanation on the relationship nor a direction, all the more so a causality.

The examination of the difference in means due to only one variable, namely the attitude towards the statement "HelloFresh makes it easy to reduce food waste", the satisfaction towards one's own food waste behaviour, or the frequency using HelloFresh necessarily does not account for other factors explaining the variance in the amount of food waste, much of which will be loaded in the error term. In the context of the General Customers Questions, it does not provide much information to the reader, who can only conclude from the analysis that there is no significant difference between the various variable levels on food waste. The further conduction of such test

[17] The ANOVA as described above was performed at household level for each of the independent variables and could not show any significance at any level.

at dinner type level considering only two variables would thus not be more informative.

Moreover, the fractioning of the sample into smaller sub-samples, by country and dinner type leads towards less power, it is to say, ability of the model to fine statistically significant difference. Given the very little expected effect size (or magnitude of the difference between groups) of the selected variables to consider, it is even more complex to identify a possible difference in mean if any, and leading in this case to a false negative (due to very low power of prediction).

Below the steps taken to compute one-way ANOVA and two-way ANOVA are nevertheless presented.

Instead of trying to identify the effect of the level of satisfaction in one's own Food Waste Management on the leftovers amount by dinner type, it is suggested to take another angle and see whether the satisfaction managing food waste with HelloFresh meal significantly differs from the satisfaction of managing food waste without HelloFresh with the help of a paired T-test.

Special Case:

A significant difference in means of total food waste per person was only observed in the case of the UK, across levels of satisfaction towards the respondents' own Food Waste Management, for each type of dinner.

- When eating a HelloFresh Meal, the total amount of food waste is significantly lower by 116 grams when the level of satisfaction is medium compared to a low level of satisfaction ($F(2, 419)=7.54$; $p=0.001$). Similarly, the total amount of food wasted is significantly lower of on average 105 grams when the level of satisfaction is high compared to when it is low ($F(2, 419)=7.54$; $p=0.002$).
- When eating a Non HelloFresh Meal prepared from scratch, the total amount of food waste is significantly lower by 108 grams when the level of satisfaction is medium compared to a low level of satisfaction ($F(2, 239)=6.95$; $p=0.001$). Similarly, the total amount of food wasted is significantly lower of on average 102 grams when the level of satisfaction is high compared to when it is low ($F(2, 239)=6.95$; $p=0.001$).
- When eating another type of meal, the total amount of food waste is significantly lower by 73 grams when the level of satisfaction is medium compared to a low level of satisfaction ($F(2, 1422)=14$; $p=0.000$). Similarly, the total amount of food wasted is significantly lower of on average 68 grams when the level of satisfaction is high compared to when it is low ($F(2, 1422)=14$; $p=0.000$).

Table 8: Overview analysis procedure step-by-step (general customer perceptions).

Steps	What we do with which variables	Number of observations in the da-

		taset
Reframing the independent variables	The variable "HelloFresh Meal Kits make it easier for me to have less food waste" (hf_easier_less_foodwaste) was transformed into a numerical variable. The variable "Satisfaction level" (satisfied_foodwaste_hf) was reframed into a variable satisf_fw_hf taking up three levels, instead of: Low level of satisfaction Medium level of satisfaction High level of satisfaction The variable "Frequence of shopping a HelloFresh Box" (shop_hf_mealkit) was transformed into a numerical variable.	
Reframing of the variable total amount of food waste per meal per person	A variable is created and takes up the value of the row total of all leftovers categories for each dinner observation: total_foodwastepp. Rowtotal equal to zero were treated as zero, not as missing values. This assumption is taken due to the high number of zero reported. These could be either due to underreporting or to real zero weight. We first assume that these were due to zero weight.	N= 1,417
Computation of descriptive statistics	The mean amount of food waste by level of each of the three categorical variables was computed, by country, for each dinner type: 1 = HelloFresh Meal 2 = Non-HelloFresh Meal 3 = Other (A semi-prepared or ready to cook fully prepared meal; Leftovers from another meal; I did not eat dinner at all tonight ; I did not eat at home tonight; A meal from a deliv-	

	ery service restaurant)	
Conduction of a one-way ANOVA for each food waste category, in each country, aggregated at the household level.	A first ANOVA was conducted to identify possible significant differences in food waste amount total_foodwastepp, depending on the level taken by the variables f_easier_less_foodwaste, satisfied_foodwaste_hf, shop_hf_mealkit No significance was shown in the overall model, implying therefore no further post hoc test.	
Conduction of a two-way ANOVA to examine the simple effect and interactions of dinner kind and level of satisfaction and attitude on the total amount of food waste per person, for each dinner in each country.	A two-way ANOVA allows investigating the simple effects and the interactions between two independent variables, namely dinner_kind and each of the variables f_easier_less_foodwaste, satisfied_foodwaste_hf, shop_hf_mealkit… …On the final outcome variable total_foodwastepp. Whenever the p-value is inferior to 0.05 further test are conducted. Example: At global level (N=9,901), this showed no significance of the interaction between dinner_kind and satisfied_foodwaste_hf (p=0.21), nor significance of simple effects of satisfied_foodwaste_hf (p=0.75) on the total amount of food waste per meal per person, therefore no significant difference in total amount of food waste depending on the dinner type or level of satisfaction. In the US (N=1,234), the interaction between dinner_kind and satisfied_foodwaste_hf is not significant (p=0.99). The simple effects of satisfied_foodwaste_hf also showed no significance	N=9,901 (Global)

	(p=0.6291) on the total amount of food waste per meal per person, therefore no significant difference in total amount of food waste depending on the dinner type or level of satisfaction.	
Conduction of post hoc tests when the ANOVA shows significance.	Any time the overall model is significant at the 5%-level (p-value<0.05), we conduct further post hoc test (Bonferroni Test) to identify which level for the variable have a significant difference in terms of amount of leftovers or food waste produced in the overall model. This applied only in the case of the UK for the variable Satisfaction in Own Food Waste Management. We examine here again whether the differences in mean are significant at the 5%-level.	

Literature

Atteslander, P.: Methoden der empirischen Sozialforschung. 7. bearb. Aufl. Berlin: Walter de Gruyter 1993

Buhl, J.; Liedtke, C.; Teubler, J.; Bienge, K. (2019): The Material Footprint of private households in Germany: Linking the natural resource use and socioeconomic characteristics of users from an online footprint calculator in Germany. Sustainable Production and Consumption, Vol 20, Pages 74-83. DOI: https://doi.org/10.1016/j.spc.2019.05.001.

Diekmann, A.: Empirische Sozialforschung. Grundlagen, Methoden, Anwendungen. Rowohlt Taschenbuchverlag, Reinbek bei Hamburg: Rowohlt Taschenbuchverlag 2002.

Heid, H. (2013). Logik, Struktur und Prozess der Qualitätsbeurteilung von Schule und Unterricht. Zeitschrift für Erziehungswissenschaft, 16 (2), 405–431. doi:10.1007/s11618-013-0363-7.

Langen, N.; Burdick, B. (2012). Forschungsbaustein B: Befragung von Privathaushalten durch die Verbraucherzentrale Nordrhein-Westfalen. In: Teitscheid et al. (Eds.): Verringerung von Lebensmittelabfällen –Identifikation von Ursachen und Handlungsoptionen in Nordrhein-Westfalen. Studie für den Runden Tisch „Neue Wertschätzung von Lebensmitteln“ des Ministeriums für Klimaschutz, Umwelt, Landwirtschaft, Natur und Verbraucherschutz des Landes Nordrhein-Westfalen, 61-82.

Leverenz, D.; Moussawel S.; Maurer, C.; Hafner, G.; Schneider, F.; Schmidt, T.; Kranert, M. (2019). Quantifying the prevention potential of avoidable food waste in households using a self-reporting approach. Resources, Conservation & Recycling 150. DOI: 10.1016/j.resconrec.2019.104417.

Lorenz-Walther, B.; Langen, N.; Göbel, C.; Engelmann, T.; Bienge, K.; Speck, M.; Teitscheid, P. (2019): What makes people leave LESS food? Testing effects of smaller portions and information in a behavioral model. DOI 10.1016/j.appet.2019.03.026.

Lukas, M.; Rohn. H.; Lettenmeier, M,; Liedtke, C.; Wiesen, K. (2016): The Nutritional Footprint – integrated methodology using Environmental and Health Indicators to indicate Potentials for Absolute Reductions of Natural Resources Use in the Segment of Food and Nutrition. Journal Cleaner Production. Special Issue – Possibilities for Resource Reduction. Vol 132. pp. 161-170. doi: 10.1016/j.jclepro.2015.02.070.

Miller, S. (2000). Introduction to manufacturing simulation. In Proceedings of the 2000 Winter Simulation Conference, (S. 63-66). Online: http://informs-sim.org/ wscOOpapers/001.PDF.

Neumeier. S. (2014): Modellierung der Erreichbarkeit von Supermärkten und Discountern. Untersuchung zum regionalen Versorgungsgrad mit Dienstleistungen der Grundversorgung. Thünen-Institut. Thünen Working Paper 16.

Raithel, J. (2008): Quantitative Forschung: ein Praxisbuch. 2. Aufl. Wiesbaden: VS, Verlag für Sozialwissenschaften.

Speck M.; Bienge K.; Wagner L.; et al. (2020): Creating Sustainable Meals Supported by the NAHGAST Online Tool - Approach and Effects on GHG Emissions and Use of Natural Resources. Sustainability 2020, 12, 1136. DOI: 10.3390/su12031136.

Stefan, K.; van Herpen, E.; Tudoran A.; Lähteenmäki, L. (2013): Avoiding food waste by Romanian consumers: The importance of planning and shopping routines. Food Quality and Preference 28 (2013), 375–381.

US Census Bureau (2019): Income and Poverty in the United States: 2018. Online: https://www.census.gov/content/dam/Census/library/publications/2019/demo/p60-266.pdf [12/05/2019].

van Geffen, L.E.J.; van Herpen, E.; van Trijp, J.C.M. (2016): Causes & Determinants of Consumers Food Waste. REFRESH Deliverable 1.1.

van Herpen, E. (2020): Appendix A – Household Food Waste Questionnaire. Internal document. Refresh – Resource Efficient Food and dRink for the Entire Supply cHain. More

insights online: https://eu-refresh.org/sites/default/files/D1.3%20final%20report%20Nov%202016.pdf.

van Herpen, E.; van der Lans, I. A.; Holthuysen, N.; Nijenhuis-de Vries, M.; & Quested, T. E. (2019): Comparing wasted apples and oranges: An assessment of methods to measure household food waste. Waste Management, 88, 71-84. https://doi.org/10.1016/j.wasman.2019.03.013.

van Herpen, E.; de Hooge, I. E. (2019): When product attitudes go to waste: Wasting products with remaining utility decreases consumers' product attitudes. Journal of Cleaner Production, 210, 410-418. https://doi.org/10.1016/j.jclepro.2018.10.331.

van Herpen et al., (2016): Consumption Life Cycle Contributions. Assessment of practical methodologies for in-home waste measurement. REFRESH Deliverable 1.3.

Wedler, K.; Karrie, S. (2017): Good Practice. Blended Learning in der internationalisierten Lehramtsausbildung. Zeitschrift für Hochschulentwicklung, 12 (4), 39–52. Online: https://www.zfhe.at/index.php/zfhe/article/view/1079.

Xu L, L.; G, Parfitt, J. et al. (2017): Missing Food, Missing Data? A Critical Review of Global Food Losses and Food Waste Data. Environmental science. 2017. Environ. Sci. Technol. DOI:10.1021/acs.est.7b00401.