# Synthesis report on
# Food Waste
## in Dutch Households in 2019

honest about food
Nutrition centre

# Contents

# Summary


- Dutch households wasted an average of 34.3 kg of solid food (including thick liquids and dairy products) per person per year in 2019.
- This is a decrease of 17% compared to 2016 (41.2 kg) and 29% compared to 2010 (48.0 kg).
- Solid food is mainly wasted via residual and vegetable, fruit & garden (VFG) waste. 26.5 kg in household waste via these routes was measured per person per year. In 2016, this was 30.4 kg.
- In addition, waste to the other routes (sink, toilet, animals, compost, etc.) is estimated at 7.8 kg. In 2016, this was 10.8 kg.
- 9.5% of purchased food is wasted. This figure was 11.1% in 2016 and 13.6% in 2010.
- Bread, dairy products, vegetables, fruit and potatoes are wasted most. In absolute quantities, however, the largest decrease is found in these products (with the exception of potatoes, which are being wasted in larger quantities).
- In addition to the waste of solid food, liquids are also wasted. An average of 45.5 litres of drinks per person per year disappeared down the sink or toilet in 2019. This is a drop of 21% compared to 2016 (57.3 litres).


## How do we measure food waste?

This report describes the measurement of the amount of food waste in Dutch households on behalf of the Ministry of Agriculture, Nature and Food Quality [LNV]. 'Food waste' refers to food appropriate for human consumption being discarded, whether or not after it has been kept beyond its expiry date or left to spoil. Samples taken in May and June 2019 were extrapolated to the whole of 2019. The same study was also conducted in 2010, 2013 and 2016. CREM Waste Management conducted a waste composition analysis of solid household waste from 130 households in 13 municipalities. Flycatcher Internet Research conducted the 'Food Waste' consumer survey based on self-assessment by 1,000 respondents. In addition, Kantar Public performed an estimation survey on the waste of liquids among 1,013 respondents via an app. This report forms a synthesis of the results of these three studies and adds a number of analyses. The Netherlands Nutrition Centre ['Voedingscentrum'] coordinated this research and was supported by a supervisory committee of experts from the Ministry of Agriculture, Nature and Food Quality, the Directorate-General for Public Works and Water Management [Rijkswaterstaat], 'Milieu Centraal' [Dutch public information service dealing with sustainable choices on energy and the environment] and Wageningen University & Research (WUR).

## How much food do consumers waste?

In 2019, Dutch households wasted an average of 34.3 kg of solid food per person per year (pppy) (including thick liquids such as soups, sauces, fats and dairy products). Of this 34.3 kg, 26.5 kg was measured in household waste (residual and VFG waste) and 7.8 kg was allocated to the other routes (sink, toilet, animals, compost, etc.). Another 15.7 kg of unavoidable food waste, such as peels, bones, stalks, etc. was also measured in residual and VFG waste, related to solid food.

Households buy an average of 377 kg of solid food pppy, of which 362 kg is edible. The 34.3 kg of food waste constitutes 9.5% of the edible food purchased by households per person.

For the whole of the Netherlands, the food wasted by consumers at home comes to 589 million kg of solid food (including dairy products, fats, sauces and soups) per year.

## Top 10 most wasted products, excluding beverages

| | | |
|---|---|---|
| 1. | Bread and bread-based products | 7.3 kg pppy |
| 2. | Dairy products | 5.1 |
| 3. | Vegetables | 3.7 |
| 4. | Fruit | 3.0 |
| 5. | Potatoes | 2.9 |
| 6. | Sauces and fats | 2.7 |
| 7. | Meat and meat products | 2.3 |
| 8. | Pasta | 1.0 |
| 9. | Pastry and cake | 1.0 |
| 10. | Sweets and snacks | 0.8 |

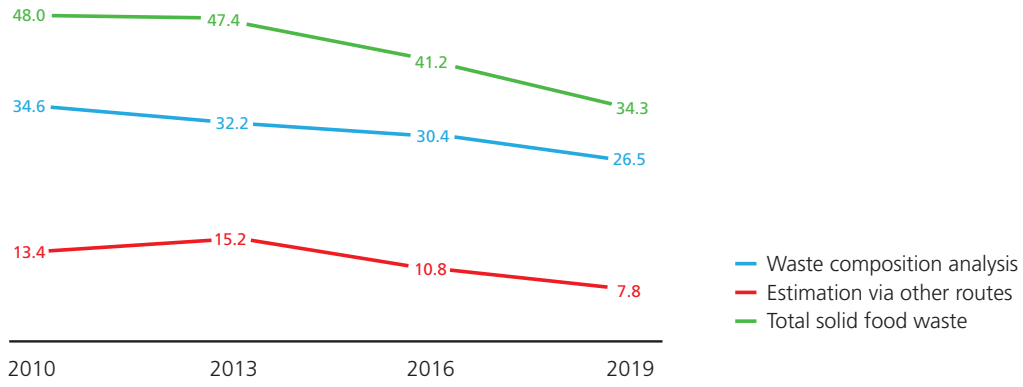
## Beverages: mainly coffee, tea and dairy drinks

It is estimated that consumers waste 45.5 litres of liquid food and beverages per year via the sewer (sink and toilet), of which:

- 23 litres of coffee and tea;
- 10 litres of milk and dairy drinks and 4 litres of thick dairy products;
- 6 litres of soft drinks and juices;
- 1 litre of sauces;
- 1 litre of wine and beer

For the whole of the Netherlands, waste via the sewer comes to 781 million litres per year. Please note that (partial) double counting occurs in the waste of dairy drinks and thick liquids (max. 4.0 kg pppy).

## Comparison with previous measurements




In 2019, households wasted 34.3 kg of solid food (including soups, fats, sauces and dairy products) per person. This is a decrease of 17% compared to the previous measurement in 2016 (41.2 kg pppy) and 29% compared to the measurement in 2010 (48.0 kg pppy).

The largest share comes from the waste composition analysis: 26.5 kg pppy. This was 30.4 kg in 2016 (a decrease of 13%) and 34.6 kg in 2010 (a decrease of 23%).

We also extrapolate the estimate for the other routes from this: 7.8 kg pppy. This figure was 10.8 kg in 2016 and 13.4 kg in 2010.

In 2019, 45.5 litres of liquid food and drink per person ended up in the sewer, a decrease of 21% compared to 2016 (57.3 litres per respondent, excluding beer and wine).

## What is the value of this food waste?

According to European figures, the value per kilo of solid food wasted by households is € 3.53 (Stenmarck et al. 2016). According to GfK, the value per kilo of solid food purchased in 2019 (including dairy products) is € 3.49 (Temminghoff 2019). By wasting solid food (including dairy products, fats, sauces and soups), households therefore throw away approximately € 120 pppy. In 2016, this figure was € 145.

## Waste throughout the chain

WUR conducts the Food Waste Monitor for the entire food chain. In 2017, the total quantity of food waste in the Netherlands in the entire chain was between a minimum of 1,814 and a maximum of 2,509 kilotons. Converted per capita, this works out at between 106 and 147 kg per person. If we estimate solid food waste in households (excluding beverages) at 34.3 kg, this means that households are responsible for around 23% to 32% of the total waste in the chain.

## Government policy

The Ministry of Agriculture, Nature and Food Quality has been pursuing a policy aimed at reducing food waste since 2009. One of the objectives of the UN Sustainable Development Goals (SDG 12.3) is halving per capita food waste by consumers and supermarkets by 2030 compared to 2015 and minimising food losses in the rest of the chain. The European Union has subscribed to this objective and the Dutch government also endorses it.

## The figures in a row

This household food waste study yields even more figures for the various routes and products. Figure 1 provides a summary of the results.

The bulk of solid food waste (including dairy products and thick liquids) is disposed of via the household waste: 67.7% (of which 30.2% via rubbish bags/bins and 37.5% via VFG; see Figure 1). This figure was 60.2% in 2016. 25.5% ends up down the sink or toilet (drinks and liquid products such as dairy products, soups and sauces), 3.7% goes to animals and 3.1% is disposed of via other routes such as a compost heap. The waste composition analysis shows that the amount of solid and thick liquid food disposed of via household waste is 26.5 kg pppy (Figure 1). Of this amount, 21.5 kg is found in the residual waste and 5.0 kg in the VFG waste.

According to the self-assessment, consumers throw away 18.3 kilos of food (solid and liquid) per person per year. Based on the results of the waste composition analysis, this appears to be an underestimation. However, the self-assessment provides insight into the different routes by means of which food is wasted.[1] Based on the percentage distribution between the various routes, extrapolating the measured amount of food waste in residual and VFG waste from the waste composition analysis to the other waste routes (7.8 kg pppy) leads to a total of 34.3 kg of food waste pppy in households.

[1] Self-assessment has so far been the only method available to estimate this, although there is no validation of this method.

| | total | residual waste | VFG waste | sink/toilet | animals | other |
|---|---|---|---|---|---|---|
| **1. Self-assessment** | 100% | 67.7% | | 25.5% | 3.7% | 3.1% |
| *waste in kilos pppy* | | **2. Waste composition analysis** | | | **Extra-polation** | |
| solid | | 18.0 | 4.9 | 0.7 | 2.0 | 0.7 |
| thick liquid and dairy products | | 3.6 | 0.0 | 4.0 | 0.1 | 0.3 |
| | **34.3** | **26.5** | | | **7.8** | |

| *waste in litres pppy* | | **3. Estimates for liquids** | |
|---|---|---|---|
| coffee and tea | | 23.2 | |
| dairy drinks | | 14.2 | |
| soft drinks and juices | | 5.7 | |
| wine and beer | | 1.3 | |
| sauces | | 1.1 | |
| | **45.5** | | |

| | |
|---|---|
| estimate for PMD | 0.4 |
| estimate for oils and fats | 0.1 |

*Figure 1: Estimation of food waste in Dutch households in 2019 via: 1. Self-assessment (distribution between routes in percentages), 2. Waste composition analysis of solid household waste (kg pppy, grey and green), extrapolation of waste composition analysis based on self-assessment percentages (sink & toilet, animals and others) and 3. Estimation of liquids via sink and toilet (litres pppy; blue). An indication of food waste via Plastic, Metal & Drinks (PMD) packaging waste and separately collected oils and fats (kg pppy) is also provided.*

Separately collected edible oils and fats have not been measured separately, but the figure will not be more than 0.1 kg pppy. Food remains in separate collected PMD (Plastic, Metal & Drinks packaging waste) have not been included either, but this will not amount to more than 0.3–0.4 kg pppy.

By applying the distribution across the routes per product group from the self-assessment to the quantities found in the waste composition analysis, we have also calculated what may be wasted via other routes. This yields an estimate of 7.8 kg of food waste via other routes (4.7 kg liquids via sink and toilet, 2.1 kg to animals and 1.0 kg to compost and other). Together, this works out at 34.3 kilos per person per year. This figure has been adjusted for water absorption by pasta and rice.

Solid food waste accounts for 9.5% of the amount of solid food purchased (including dairy products and thick liquids). This figure was 11.1% in 2016 and 13.6% in 2010. The most wasted solid foods are bread (21% of total waste; see Table 1), dairy products (15%), vegetables (11%), fruit (9%) and potatoes (8%). Meat is no longer in the top 5. In 2016, the top 5 were bread (22%), dairy products (17%), vegetables (14%), fruit (12%) and meat (7%). Relative to the quantity purchased, rice is the most wasted product at 39%, followed by pasta (34%) and bread (21%).

The amount of liquid waste via sinks and toilets has also been estimated (shown in blue in Figure 1). This amounts to 45.5 litres per person per year. This is 11.8 litres less than in 2016 (57.3 litres per respondent in 2016).[2] This involves 14.2 litres of dairy products and 1.1 litres of thick liquids (sauces). In particular, a lot of coffee and tea (23.2 litres) is wasted. 5.7 litres of soft drinks and juice are wasted per person per year. Beer and wine were measured for the first time this year. Together, these are wasted at the rate of 1.1 litres per person per year.

The numbers for household waste and sewage (sink and toilet) cannot be added together, as they involve different measurement methods and partly overlap. This is because the waste of dairy products and thick liquids is measured in both ways.

*Table 1: Most wasted solid and thick liquid foods in 2019 (both absolute and relative)*

| Top ten | Absolute waste per product group (kg PPPY and % of total waste) | | | Top ten | Relative waste per product group (% waste of purchased quantity)[a)] | |
|---|---|---|---|---|---|---|
| 1 | Bread & bread-based products | 7.3 | 21% | 1 | Rice[b)] | 39% |
| 2 | Dairy products | 5.1 | 15% | 3 | Pasta[b)] | 34% |
| 3 | Vegetables | 3.7 | 11% | 2 | Bread & bread-based products | 21% |
| 4 | Fruit | 3.0 | 9% | 4 | Sauces and fats | 17% |
| 5 | Potatoes | 2.9 | 8% | 5 | Potatoes | 14% |
| 6 | Sauces and fats | 2.7 | 8% | 6 | Dairy products | 14% |
| 7 | Meat & meat products | 2.3 | 7% | 7 | Pastry and cake | 9% |
| 8 | Pasta | 1.0 | 3% | 8 | Vegetables | 9% |
| 9 | Pastry and cake | 1.0 | 3% | 9 | Fruit | 8% |
| 10 | Sweets and snacks | 0.8 | 2% | 10 | Fish | 8% |
| 11 | Rice | 0.8 | 2% | | | |

*Please note: rounded numbers*
*a) Calculated for the avoidable portion of the product.*
*b) Adjusted for water absorption during cooking (% of dry product as purchased).*

[2] See Methods for the difference between person and respondent.

# 1. Introduction

The Ministry of Agriculture, Nature and Food Quality has been pursuing a policy aimed at reducing food waste since 2009. One of the objectives of the UN Sustainable Development Goals (SDG 12.3) is halving per capita food waste by consumers and supermarkets by 2030 compared to 2015. The European Union has subscribed to this objective and the Netherlands also endorses it. In line with SDG 12.3, the Stichting Samen Tegen Voedselverspilling [Foundation United against Food Waste] and the parties to the Climate Agreement (2019) have set themselves the goal of halving food waste among consumers, including food losses in the chain, in the Netherlands by 2030 compared to 2015.

In order to monitor these objectives, it is important to measure progress on a regular basis. The Ministry of Agriculture, Nature and Food Quality has therefore decided to investigate food waste in households in the Netherlands once again in 2019. The Ministry of Agriculture, Nature and Food Quality asked the Netherlands Nutrition Centre to coordinate the research in 2019, as was also the case for the previous study in 2016.

On 3 May 2019, the European Commission (EC) presented a proposal for the application of the delegated decision on mandatory uniform measurement of levels of food waste in all EU countries (see the appendix for more details). This concerns the quantities of 'food waste regarded as composed of parts of food intended to be ingested by humans'. This includes a separate measurement of food waste in households at least every four years. This has been carried out in the Netherlands every three years since 2010. Food waste that is discharged via wastewater (i.e. sink and toilet) does not need to be measured, but is estimated and reported separately in this report in line with agreements within the EC (EC 2019).

The chosen methodology broadly follows the *'Food waste quantification manual to monitor food waste amounts and progression'* (Tostivint et al. 2016). For example, this means that packaging is not included. In some cases, we have deliberately deviated from the method in order to ensure comparability with previous measurements. Any deviation from the method is indicated in this report.

The scope is Dutch households. Households are defined as *'One or more people who share a living space and provide themselves with their daily requirements in a non-business manner'* (Statistics Netherlands (CBS) 2019). Household food waste concerns the food waste of these daily requirements that are discarded in or around the living space via the regular route (Tostivint et al. 2016). However, this report also examines other routes, such as waste being fed to animals in and around the house, deposited on compost heaps or in public waste bins.

## 1.1 Synthesis of three studies

This report presents the synthesis, summary and conclusions of three studies that complement each other and were carried out in the same period:

1. Elianne Derksen & Pleun Aardening (June 2019), **Voedselverspilling zelfrapportage; Inschatting van de hoeveelheid voedselverspilling per jaar door Nederlandse consumenten op basis van zelfrapportage** [Food waste self-assessment; Estimation of the amount of food waste per year by Dutch consumers based on self-assessment], Flycatcher Internet Research, Maastricht.
2. Frits Steenhuisen (August 2019), **Voedselverspilling in fijn huishoudelijk restafval en GFT-afval, Nederland 2019** [Food waste in fine household residual waste and VFG waste, The Netherlands 2019], CREM Waste Management, Amsterdam.
3. Manuel Kaal & Sabine Hooijmans (28 June 2019), **Onderzoek vloeistofverspilling van Nederlanders thuis** [Study on liquid waste by Dutch people at home], Kantar Public, Amsterdam.

In this report, we refer to the above as 1. Self-assessment (Derksen and Aardening 2019), 2. Waste composition analysis (solid, thick liquid and dairy products) (Steenhuisen 2019) and 3. Liquid Waste Estimation Survey (Kaal and Hooijmans 2019).

Flycatcher Internet Research was commissioned by the Netherlands Nutrition Centre to conduct a quantitative study on domestic food waste via various waste routes, based on self-assessment. This study also provides an opportunity to measure waste awareness indicators and to gain insight into the relationship with alternative disposal routes.

At the request of the Nutrition Centre, CREM Waste Management performed a waste composition analysis to chart out in detail the amount and composition of food waste and unavoidable food losses in residual and VFG waste in households in the Netherlands. In 2010, 2013 and 2016, CREM Waste Management also identified in detail the amount and composition of domestic food waste and unavoidable losses in the Netherlands (Steenhuisen 2017). These analyses were carried out in the context of national policy that was implemented to reduce food waste. In addition to generating reliable data on food waste for monitoring the results of current and future policy, and for further investigation into the effects (environmental and otherwise) of food waste, it may contribute to more insights into the nature of food waste (such as the type of products, untouched or prepared). To determine the amount and composition of food waste in household waste, the primary method used was the physical measurement of food in residual waste and VFG waste.

On behalf of the Netherlands Nutrition Centre, Kantar Public conducted a second study into the extent of liquid waste by Dutch people in their own homes via the sewer (sink and toilet). Waste outside the home was not included in this study. This study is based only on drinkable liquids, thick dairy products and sauces, with the exception of tap water. Wine and beer were included in the study for the first time this year.

## 1.2 Research objectives

### 1.2.1 Self-assessment (solid and liquid)

*The aim of the Flycatcher study is to estimate the amount of food waste per year by Dutch consumers based on self-assessment and determine which waste routes are used to dispose of specific product groups.*

In addition, Flycatcher looked for any differences between the amounts of wasted food based on a number of behavioural determinants and social demographic characteristics. As a result, the study can provide more insight into the reasons underlying domestic food waste.

Through this study, we arrive at an estimate of the amount of self-reported waste of solid and liquid foods (beverages and dairy products), and the waste routes for each product group by means of which the waste occurs.

### 1.2.2 Waste composition analysis (solid, thick liquid and dairy products)

*The aim of this study is to determine the amount and composition of food waste through residual waste and VFG waste in Dutch households in 2019.*

The research questions associated with this problem are:

1. What is the volume of food waste (solid, thick liquid and dairy products) in households through residual waste and VFG waste (in kilos per household and per capita per year)?
2. What is the composition of food waste in households in weight percentages?
3. How do the current amount and composition of food waste compare to the figures for 2010, 2013 and 2016?

The method adopted is the same as in the previous studies.

### 1.2.3 Liquid Waste Estimation Survey

*The aim of this study is to estimate the amount of drinkable liquids wasted in the Netherlands at a personal level. This concerns waste via the sewer. The results of this study will be compared with the results of the study conducted in 2016.*

The following drinkable liquids were included in the study: milk and buttermilk, dairy beverages (such as drinking yoghurt), soft drinks and juices, wine, beer, coffee and tea. An estimate is also made for thick dairy products (yoghurts, quark, custards, etc.) and sauces that are disposed of via the sink or toilet. Water (including packaged mineral water) falls outside the scope of the study.

## 1.3 Definition of 'food waste'

*'Food waste' refers to food appropriate for human consumption being discarded, whether or not after it has been kept beyond its expiry date or left to spoil (FAO, 2013). European legislation applies the following, comparable definition: 'Food waste regarded as composed of parts of food intended to be ingested by humans' (EC 2019).*

This refers to the edible parts of food, or avoidable losses. In addition to avoidable losses, there are unavoidable food losses in the food chain and in households. These include, for example, peels, stalks, cheese rinds, egg-shells, coffee grounds, tea bags and meat and fish remains (bones). Crops or residual streams that are not intended for human consumption (such as animal feed) are not covered by the definition and are therefore not included in the quantification of waste (Soethoudt and Timmermans 2013).

## 1.4 Study design

The Ministry of Agriculture, Nature and Food Quality has asked the Netherlands Nutrition Centre to coordinate the research that provides insights into food waste by consumers. The supervisory committee of these studies consisted of:

- Ministry of Economic Affairs; Tessa Ooijendijk;
- Directorate-General for Public Works and Water Management [Rijkswaterstaat]; Olaf Janmaat;
- Wageningen University & Research; Han Soethoudt;
- Milieu Centraal; Jonna Snoek and Kirsten Palland;
- Netherlands Nutrition Centre (Voedingscentrum); Corné van Dooren, Marjolijn Schrijnen and Marthe Huigens.

The committee reviewed both the individual studies and this synthesis report. Flycatcher, CREM Waste Management and Kantar Public conducted the studies.

# 2. Methods

The research was divided into three steps:

1. Determination of the main routes of food waste per product group through self-assessment (by means of a frequency questionnaire).
2. Determination of the amount of solid food waste via household waste: residual waste and VFG waste (by means of a waste composition analysis).
3. Estimation of liquid food waste via sinks and toilets (by means of an app).

Possible food waste routes that are distinguished in this study:

- Rubbish bags, rubbish bins, residual waste;
- Organic waste bin, VFG waste
- Sink[4]
- Toilet;
- Outdoor animals (birds, deer, etc.)[4]
- Pets
- Compost heap
- Outdoor rubbish bins (in the public space)
- Other

The most common method for measuring food waste routes is a diary or questionnaire (Tostivint et al. 2016).

In order to be able to compare the results well with the 2010, 2013 and 2016 surveys, the same methodology has been used wherever possible. The method as implemented in 2016 was published in the scientific journal Waste Management (Van Dooren et al. 2019).

## 2.1 Self-assessment: frequency questionnaire

The self-assessment was conducted by Flycatcher using an online questionnaire. The target group for the research consisted of Dutch people aged 18 years and over. The research group was selected from the ISO-certified Flycatcher panel. The sample was stratified by gender, age, education and province. This means the people in the sample were representative of the Dutch population aged 18 and above for these characteristics.

The sample size was 1,673 panel members, 1,000 of whom ultimately completed the questionnaire in full (60% response rate). The questionnaire was sent out on Friday 17 May 2019 and could be completed until Friday 31 May 2019. The online questionnaire consisted of 77 questions and took an average of 25 minutes to complete. If desired, the completion of the questionnaire could be discontinued and resumed at a later date, without the respondents having to answer questions that they had already completed. Each respondent could only complete the questionnaire once.

Differences between groups of respondents were statistically tested for significance by means of a t-test.

[3] FUSIONS also recommends looking at 'Sewer waste, mainly via the kitchen sink and dishwashers & Home composting'
[4] This differs from FUSIONS: 'food fed to animals (e.g., family pets, wild birds, chickens or pigs kept in the garden) is not defined as food waste and shall not be included as in food waste quantification.'

Calculation of volumes and percentages per waste route: respondents could indicate how much food they discarded (on a 5-point scale) and how often they did so (on a 7-point scale), on average (by their own estimation). Per product group, the frequency of waste production was requested:

- every day or almost every day;
- a couple of times per week;
- a maximum of once per week;
- a maximum of once per month;
- a couple of times per year at most;
- rarely or never.

The frequency was multiplied by the volume in kilograms, resulting in an average estimate of the number of kilos of wasted product per year. For liquids, the same method was applied, assuming 1 litre = 1 kilo.

Respondents could indicate (for each product category) the routes they use to dispose of their waste. For this purpose, they could divide 100 points across the various waste routes. These 100 points represented the percentage that is disposed of on average via one of these waste routes. An average percentage was calculated per waste route.

To ensure comparability with previous measurements, only necessary changes were made to the questionnaire. In some cases, the dimensions of products (such as the volume of a cup) were adjusted on the basis of new insights. In 2016, the survey was conducted by Kantar Public with a different panel. Due to European tendering rules, a different agency was chosen this time.

## 2.2 Waste composition analysis (solid, thick liquid and dairy products)

The amount and composition of food waste via biodegradable kitchen waste ('VFG waste') and mixed municipal waste ('residual waste') were determined using waste composition analyses of 130 residual waste samples (from 130 households in 13 municipalities) and 110 VFG waste samples (from 110 households in 11 of these 13 municipalities). The study aims to replicate the 2016 study as accurately as possible. The same municipalities from the 2016 study were used.

The samples of household residual and VFG waste on the basis of which the national food waste was determined came from the following 13 municipalities: Amsterdam, Apeldoorn, Arnhem, Assen, Blaricum, De Friese Meren (Lemmer), Drechterland (Venhuizen), Harderwijk, Rijswijk, Rotterdam, Son en Breugel, Staphorst and Waddinxveen. This selection ties in with the Rijkswaterstaat methodology (Rijkswaterstaat 2016).

*Figure 2: Impression of the working method during the waste composition analysis*

In each municipality, the residual waste and VFG waste of 10 households was collected separately (in a Big Bag) and sorted. The 10 samples were taken from 3 different locations (streets) in each municipality. In the 3 municipalities where residual waste is collected via underground collection containers (Amsterdam, Arnhem and Apeldoorn), 25 bags were collected from 3 different container locations. It is assumed that an average of 2.5 bags per household, per week will be collected. Each of these bags was regarded as a separate sample and sorted separately.

To minimise the risk of influencing disposal behaviour, the households whose waste was collected for sorting were not approached in advance. In line with GDPR legislation, the samples cannot be traced back to an address or person.

The measurements were carried out in May/June 2019.[5] The previous analyses also took place in the spring of 2010 and 2013. Due to the later start in 2016, sampling took place in the autumn of that year (October/November).[6] A total of 240 samples of 130 households were taken (130 for residual waste and 110 for VFG waste). Each sample was sorted separately in order to determine the quantity of food waste for each household, and its composition. The residual and VFG waste of each household was manually sorted on a table at a central location.

First of all, a distinction was made during sorting between food waste and unavoidable food losses (such as peels, bones, tea bags and coffee grounds). All food remains were individually weighed and classified according to 350 different components that form part of 7 categories of unavoidable and 17 categories of avoidable food waste. The waste was also sorted according to the following characteristics:

- prepared/not prepared; this concerns food that is prepared at home (or delivered or collected already prepared), such as roasted meat or cooked vegetables;
- packaging opened/not opened; this concerns food remains whose packaging is still closed or has already been opened.

To obtain the average amount and composition for the Netherlands, the average composition of food losses and waste per municipality (district type[7]) was first determined by adding up the weights per product category of the 10 households and dividing this by the total weight. Subsequently, the weight percentages of the municipalities (district types) were added together and weighted using the weighting ratios for 2019 determined by Rijkswaterstaat.[8]

## 2.3 Liquid Waste Estimation Survey

Kantar Public assumed a net sample of 1,013 respondents. These were drawn from their own panel and representative of gender, age, region, household size and education. This sample is of sufficient size to enable reliable estimates of household waste. In order to arrive at a conclusion per person, one of the authorised parents was invited to act on behalf of respondents under the age of 16. They conducted the survey on behalf of their child. This was not done in 2016, when the 'housekeeper' was asked to complete the survey. It was assumed that the housekeeper would also discard drinks for the other family members.

[5] No adjustment for seasonality was applied.
[6] In 2016, a seasonal adjustment was made by not counting any pumpkins found (Halloween). No adjustment was made this year.
[7] Includes type of buildings, houses, flats, high-rise buildings.
[8] The 2010 and 2013 measurements used weighting factors based on population numbers, while the 2016 and 2019 measurements used adjusted weighting factors based on the amount of residual waste in these cities.

The respondents installed an app developed for this study. Kantar Public recorded the respondents' drinking behaviour three times a day for two days. This took place in accordance with the schedule below, with the first message of the day also asking about the waste during the evening before (after 9 pm). Mobile research offers the advantage of giving respondents the opportunity to respond 'in the moment' by means of a trigger based on time. By sending participants push notifications on their mobile phone at specific times, we were able to track respondents' experiences at the most relevant moment. Bias can be minimised as a result of regular reminders (Tostivint et al. 2016). This provided a good picture of the waste of beverages.

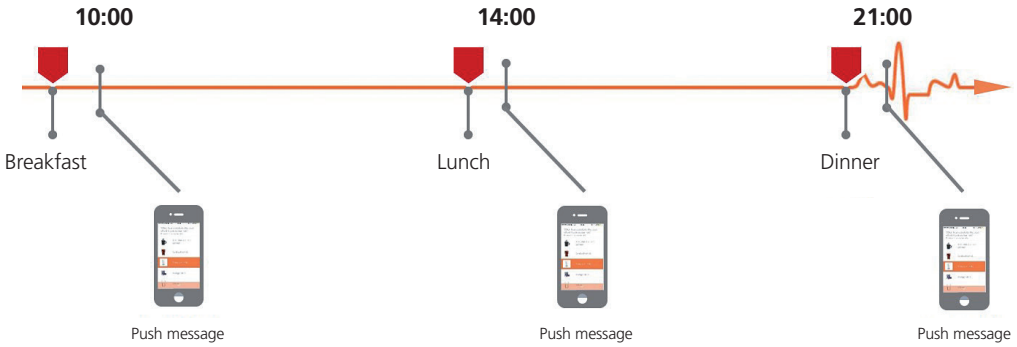



*Figure 3: Schedule of push notifications at specific times for the liquid waste survey.*

To show an average week of liquid waste, the gross sample was randomly divided into three groups that were invited to participate in the study for two or three days. The two-day groups participated in the study on two weekdays. The three-day group participated in the study on Friday, Saturday and Sunday. Together, the entire net sample completed one week.

The questionnaire asked about waste from glasses/cups and waste from bulk packaging (cartons/bottles/jars). The survey asked about waste in relative terms (full, three-quarters, half, quarter or the last bit). The report indicated the total waste per product group.

The following types of liquids were included in the study: milk and/or buttermilk, dairy beverages, thick dairy products, soft drinks and/or juices, coffee and/or tea, sauces, beer and wine.

## 2.4 Purchase of food by households

Data on which food products were purchased by households were obtained from market research institute GfK.data cover a whole year, namely the period from week 27 in 2018 to week 26 in 2019 inclusive. According to the 2013 and 2016 reports, it relates to the volumes per purchasing household and the percentage of purchasing households. The data are required to determine the amount of waste in relation to purchased foodstuffs per product group.

Since pasta and rice absorb a lot of water during preparation and are usually purchased in dried form, the quantities of pasta and rice found in the waste composition analysis was calculated back to dry quantities (a factor of 2.5 for rice and 1.8 for pasta[9] (Van Dooren et al. 2019) for comparison with the purchase volumes and previous years.

[9] In 2016 and earlier, a factor of 2.5 was also used for pasta and the total measured amount of wasted pasta and rice was calculated back to the dry form. This time, the recalculation was only carried out for the percentage prepared, which makes the final figure higher.

# 3. Results

## 3.1 Self-assessment

### 3.1.1 Disposal routes in percentages

In the self-assessment, the Dutch report that they waste an average of 18.3 kg of food pppy. In 2016, the figure was 21.2 kg (difference of -2.9 kg; -14%). This difference is not significant. However, the decrease is significant in a number of product groups: bread, leftovers from meals, oil, gravy & frying fat and tea. The amount of wasted potatoes has risen significantly. Dutch respondents estimated that they waste an average of 11.4 kilograms of solid food and 6.9 litres of liquid foodstuffs (of which 3.8 litres consists of beverages). Dairy products make up 2.6 litres of the liquid component. In 2016, 9.6 litres of liquid waste were reported.

*Table 2: Food waste disposal routes in percentages (self-assessment; largest routes in bold).*

| Category | grams/ ml | residual waste | VFG waste | outdoor rubbish bin | sink | toilet | compost heap | pets | outdoor animals | other |
|---|---|---|---|---|---|---|---|---|---|---|
| Meat | 256 | **48%** | 43% | 1% | 0% | 1% | 1% | 3% | 2% | 0% |
| Meat products | 176 | **50%** | 43% | 1% | 0% | 1% | 0% | 4% | 1% | 1% |
| Fish | 118 | 52% | 38% | 2% | **0%** | 3% | 2% | 3% | 1% | 0% |
| Cheese | 213 | **48%** | 44% | 1% | 0% | 0% | 1% | 2% | 2% | 1% |
| Butter, margarine | 89 | **67%** | 20% | 1% | 6% | 1% | 0% | 3% | 0% | 1% |
| Sweet and savoury spreads | 50 | 62% | **23%** | 1% | 4% | 1% | 2% | 1% | 0% | 7% |
| Eggs | 321 | **42%** | 51% | 1% | 1% | 1% | 4% | 0% | 0% | 0% |
| Vegetables | 1.693 | **30%** | 63% | 0% | 0% | 0% | 3% | 2% | 1% | 1% |
| Fruit | 2.319 | **27%** | 64% | 0% | 0% | 0% | 3% | 2% | 3% | 0% |
| Potatoes | 1.476 | **29%** | 64% | 1% | 0% | 1% | 3% | 1% | 1% | 0% |
| Rice | 347 | 32% | 55% | 1% | 0% | **3%** | 0% | 4% | 5% | 1% |
| Pasta, couscous | 383 | 36% | 55% | 0% | **0%** | 3% | 2% | 2% | 2% | 0% |
| Bread | 1.507 | 35% | 45% | 0% | **0%** | 0% | 1% | 3% | 15% | 1% |
| Pastry and cake | 121 | 46% | 49% | 1% | **0%** | 0% | 1% | 2% | 1% | 0% |
| Sweets, chocolate and snacks | 56 | 70% | 25% | 3% | **0%** | 0% | 1% | 1% | 1% | 0% |
| Leftovers from meals | 2.310 | 41% | 52% | 0% | **0%** | 1% | 2% | 2% | 1% | 1% |
| Yoghurt, custard and quark | 1.280 | 37% | 10% | 0% | **42%** | 9% | 0% | 1% | 0% | 1% |
| Sauces | 350 | 70% | 10% | 2% | **8%** | 2% | 1% | 0% | 0% | 7% |
| Gravy, frying fat, oil | 955 | 44% | 17% | 2% | **21%** | 6% | 0% | 0% | 0% | 10% |
| Soup | 483 | 14% | **15%** | 0% | 24% | 44% | 0% | 1% | 0% | 1% |
| Dairy drink | 491 | **20%** | 4% | 0% | 66% | 7% | 1% | 1% | 1% | 1% |
| Coffee | 696 | **5%** | **6%** | 0% | 84% | 1% | 1% | 2% | 0% | 0% |
| Tea | 360 | 5% | 0% | 2% | **88%** | 2% | 0% | 2% | 2% | 0% |
| Soft drink | 489 | 4% | 1% | 0% | **92%** | 3% | 0% | 0% | 1% | 0% |
| Fruit juice | 322 | 6% | **1%** | 0% | 89% | 4% | 0% | 1% | 0% | 0% |
| Milk | 879 | **13%** | 3% | 0% | 75% | 7% | 0% | 1% | 0% | 1% |
| Wine | 342 | 2% | 0% | 1% | **95%** | 2% | 0% | 1% | 0% | 0% |
| Beer | 217 | 7% | 0% | 1% | **88%** | 1% | 0% | 0% | 0% | 2% |
| **Total** | **18.299** | **30.2%** | **37.5%** | **0.4%** | **22.1%** | **3.4%** | **1.5%** | **1.6%** | **2.1%** | **1.1%** |

The largest waste routes are (Table 2): VFG at 37.5%, rubbish bins/bags at 30.2% and sink at 22.1% (supplemented with toilet 3.4%). Animals account for 3.7%. The rest is 3.1%.

The route differs greatly per product group. Solid food waste and liquids (drinks) are mainly disposed of via household waste (residual and VFG) and sinks, respectively. Two-thirds of potatoes, vegetables and fruit end up in VFG waste, soup is mainly disposed of down the toilet and part of the wasted bread (18%) goes to pets and outdoor animals.

### 3.1.2 Determinants explaining differences in levels of waste (self-assessment)

The weight of food wasted per person depends, among other things, on the level of education, income and household size. The household composition has the biggest effect on the amount of food wasted per year.[10]

- For example, households with three or more people throw away significantly more food per person than households with one or two people.
- Households in which children are present also waste more per person than households without children.
- Although the difference is not significant, households with young children appear to waste more food than households with children in secondary school or above.
- Respondents under the age of 55 (people aged 34 or younger waste three times as much as those aged 55+) and respondents with an above-average income in particular waste a lot of food (people with an above-average income waste twice as much as those with an average income).
- Respondents from the south of the Netherlands appear to waste more food (no significant difference).
- When it comes to behavioural determinants, respondents who are already consciously engaged[11] in less wasteful behaviour usually waste the least food.
- The use of a shopping list (people who 'always' use a list waste half as much food as those who 'never' use a list), planning the groceries, checking the kitchen cupboard/refrigerator/freezer, cooking appropriate amounts and proper consideration are determinants that positively influence the degree of food waste by at least halving it.
- Conversely, the immediate disposal of products that are past their expiry date, buying and cooking too much food, having too much food in the house and not using leftovers adversely affect the level of food waste by a factor of at least two.
- Respondents who probably or certainly do not wish to reduce their food waste in the future are also the ones who currently waste the most food.

[10] Not adjusted for purchases and consumption patterns.
[11] Measured as 'Were you aware of your own wasteful behaviour prior to completing this questionnaire?'

### 3.1.3 Waste frequency is decreasing (self-assessment)

The following frequency table shows how often people said they discarded a certain product away in 2010, 2016 and 2019. Table 3 gives a summary of two frequencies. The frequency indicates how often something is thrown away, but not how much is thrown away.[12]

*Table 3: Waste frequency (self-assessment)*

| | Almost every day | | | Rarely or never | | |
|---|---|---|---|---|---|---|
| **Solid** | **2010** | **2016** | **2019** | **2010** | **2016** | **2019** |
| Meat | 6% | 1% | 0% | 55% | 71% | 67% |
| Meat products | | | 0% | | | 50% |
| Fish | | | 0% | | | 75% |
| Cheese | 6% | 0% | 0% | 63% | 76% | 76% |
| Yoghurt, custard and quark | 5% | 0% | 0% | 45% | 60% | 61% |
| Butter/margarine | 7% | 0% | 0% | 76% | 91% | 90% |
| Spreads | | | 0% | | | 84% |
| Eggs | 1% | 0% | 0% | 67% | 79% | 78% |
| Fruit and vegetables | 7% | 1% | | 31% | 35% | |
| Vegetables | | | 1% | | | 44% |
| Fruit | | | 0% | | | 36% |
| Potatoes | | 0% | 0% | | 60% | 57% |
| Rice, pasta and couscous | | 0% | | | 73% | |
| Rice | | | 0% | | | 86% |
| Pasta and couscous | | | 0% | | | 83% |
| Bread | 10% | 1% | 1% | 36% | 43% | 46% |
| Pastry and cake | | | 0% | | | 76% |
| Sweets, chocolate and snacks | | | 0% | | | 85% |
| Leftovers from meals | 3% | 2% | 1% | 28% | 39% | 39% |
| Sauces | 2% | 0% | 0% | 39% | 50% | 56% |
| Gravy, frying fat or oil | 9% | 3% | 1% | 32% | 46% | 63% |
| **Liquid** | | | | | | |
| Soup | 1% | 0% | 0% | 56% | 72% | 77% |
| Dairy drink | 2% | 0% | 0% | 50% | 58% | 56% |
| Coffee | 8% | 2% | 1% | 65% | 76% | 87% |
| Tea | 5% | 2% | 0% | 68% | 79% | 92% |
| Soft drink | 3% | 0% | 0% | 74% | 73% | 79% |
| Fruit juice | 2% | 0% | 0% | 66% | 68% | 72% |
| Milk and milk substitutes | 3% | 2% | 2% | 28% | 39% | 2% |
| Wine | 2% | 0% | 0% | 39% | 50% | 0% |
| Beer | 2% | 0% | 0% | 39% | 50% | 0% |

[12] Ultimately, a calculation was made for frequency x estimated quantity, on the basis of almost every day = 300x/year, a few times per week = 150x, at least 1x per week = 50x, max. 1x per month = 10x, at most a few times per year = 5x and rarely/never = 1x.

It is striking that the 'rarely or never' frequency of waste has increased for almost all beverages since 2016 (except dairy drink); for solid products, the frequency of 'rarely or never' has remained approximately the same compared to 2016, but the frequency of waste has decreased overall compared to 2010. For pasta, rice, sauces and gravy, however, an increase in 'rarely/never' is evident compared to 2016. In 2010, more than 5% of respondents still threw away a number of products 'almost every day', but that figure is now 0–1% of respondents for all products. In general, therefore, food is discarded less frequently than in 2016 and 2010.

As shown in the following section, and as we know from earlier research, self-assessment results in a strong underestimation of food waste (see Discussion). This is why we primarily use the results to find out more about the relationship between routes and the differences between product groups.

## 3.2 Waste composition analysis (solid, thick liquid and dairy products): downward trend

*Table 4: Distribution of food waste via household waste between avoidable and unavoidable, prepared and unprepared, and adjusted for water absorption (2010, 2013, 2016 and 2019) (Steenhuisen 2017, Steenhuisen 2019)*

| | 2010 | 2013 | 2016 | 2019 |
|---|---|---|---|---|
| Food waste via household waste | 66.7 | 64.3 | 63.1 | 52.1 |
| Unavoidable | 28.5 | 29.7 | 29.7 | 24.5 |
| Avoidable | 38.2 | 34.6 | 33.4 | 27.6 |
| *of which in VFG waste* | *6.7* | *7.7* | *10.0* | *5.2* |
| *of which in residual waste* | *31.5* | *26.9* | *23.4* | *22.5* |
| *of which prepared* | | *9.3* | *4.3* | *10.1* |
| *of which unprepared* | | *20.1* | *23.8* | *12.7* |
| *of which untouched* | | *5.2* | *5.4* | *4.8* |
| Avoidable after adjustment for water | 34.6 | 32.2 | 30.4 | 26.5 |

Table 4 shows how food waste via household waste is divided between avoidable and unavoidable losses. This shows that 53% (27.6 kg, unadjusted for water absorption) of the food thrown away consists of avoidable food waste, compared with 57% in 2010, 54% in 2013 and 53% in 2016. The shift in the amount of avoidable food waste from residual waste to VFG waste continues to increase slightly in percentage terms. The figures in the waste composition analysis have been adjusted for water absorption by pasta and rice, after which they reached 26.5 kg. The food waste from the waste composition analysis shows a declining trend: 34.6 kg in 2010, 32.2 kg in 2013, 30.4 kg in 2016 and 26.5 kg in 2019.

The total amount of residual and VFG waste from households has decreased by a total of 11% since 2010 (-14% per inhabitant) and the percentage of avoidable food remains in residual waste has decreased since 2010; in VFG waste, this percentage increased between 2010 and 2016 (58%) and has since levelled out (+6%) (CBS 2019).

About 37% (10.1 kg pppy) of the food we waste in the Netherlands is prepared food, (e.g., cooked or fried products). This is a striking increase of 4.8 kg compared to 2016, when it was 13% (4.3 kg).[13] Incidentally, this figure was 9.3 kg in 2013. About 17% (4.8 kg) of the food is still untouched inside its packaging, or peel (comparable with 2016, 17%: 5.4 kg).

[13] This is difficult to explain, but consumers may be buying less unprepared and more prepared food and/or collecting it or having it delivered. In the self-assessment, the amount of leftovers from meals is also increasing.

## 3.3 Integration of results of the self-assessment and the waste composition analysis (solid, dairy products and thick liquid)

To arrive at a good estimate of the waste routes outside of household waste (residual and VFG waste), for the solid products we have integrated the results of the self-assessment (in percentages) with the results of the waste composition analysis (Table 5). By applying the ratio in percentages of other routes to the weights from the waste composition analysis, we have made a calculation of waste via other routes. The solid food waste via other routes is thus set at 7.8 kilos per person per year, which brings the total waste estimate to 34.3 kilos per person per year.

*Table 5: Waste per product group of solid food via residual waste, VFG waste and other routes (calculated based on percentages from the self-assessment).*

| | Self-assessment | | | | Sorting analysis avoidable (solid) | | | | Other routes | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product groups** | **% residual** | **% VFG** | **% residual + VFG** | **other routes** | **residual kg pppy** | **VFG kg pppy** | **total kg pppy** | **%** | | **kg pppy** | **%** |
| Meat | 48% | 43% | 92% | 8% | 1.33 | 0.16 | 1.49 | 5.6% | 0.13 | 1.62 | 4.7% |
| Meat products | 50% | 43% | 93% | 7% | 0.57 | 0.06 | 0.63 | 2.4% | 0.05 | 0.68 | 2.0% |
| Fish | 52% | 38% | 90% | 10% | 0.22 | 0.01 | 0.23 | 0.9% | 0.02 | 0.25 | 0.7% |
| Cheese | 48% | 44% | 92% | 8% | 0.52 | 0.05 | 0.57 | 2.2% | 0.05 | 0.62 | 1.8% |
| Dairy products (mainly thick)* | 27% | 7% | 34% | 66% | 1.76 | - | 1.76 | 6.6% | 3.38 | 5.14 | 15.0% |
| Eggs | 42% | 51% | 93% | 7% | 0.29 | 0.04 | 0.33 | 1.2% | 0.02 | 0.35 | 1.0% |
| Vegetables | 30% | 63% | 93% | 7% | 2.25 | 1.19 | 3.44 | 13.0% | 0.25 | 3.69 | 10.8% |
| Fruit | 30% | 63% | 93% | 7% | 1.66 | 1.11 | 2.77 | 10.4% | 0.20 | 2.97 | 8.7% |
| Potatoes | 29% | 64% | 93% | 7% | 1.88 | 0.80 | 2.68 | 10.1% | 0.19 | 2.87 | 8.4% |
| Bread | 35% | 45% | 80% | 20% | 4.32 | 0.79 | 5.11 | 19.3% | 1.26 | 6.37 | 18.6% |
| Pastry and cake | 46% | 49% | 95% | 5% | 0.84 | 0.09 | 0.93 | 3.5% | 0.05 | 0.98 | 2.9% |
| Bread-based products** | 35% | 45% | 80% | 20% | 0.61 | 0.12 | 0.73 | 2.8% | 0.18 | 0.91 | 2.7% |
| Leftovers from meals | 41% | 52% | 94% | 6% | 0.10 | - | 0.10 | 0.4% | 0.01 | 0.11 | 0.3% |
| Rice*** | 32% | 55% | 87% | 13% | 0.64 | 0.09 | 0.72 | 2.7% | 0.11 | 0.83 | 2.4% |
| Pasta*** | 32% | 55% | 87% | 13% | 0.69 | 0.21 | 0.90 | 3.4% | 0.14 | 1.04 | 3.0% |
| Sweets and snacks | 70% | 25% | 95% | 5% | 0.72 | 0.05 | 0.77 | 2.9% | 0.04 | 0.81 | 2.4% |
| Sandwich toppings | 62% | 23% | 85% | 15% | 0.11 | - | 0.11 | 0.4% | 0.02 | 0.13 | 0.4% |
| Sauces and fats | 51% | 15% | 66% | 34% | 1.77 | 0.04 | 1.81 | 6.8% | 0.93 | 2.74 | 8.0% |
| Soups | 14% | 15% | 29% | 71% | 0.01 | - | 0.01 | 0.0% | 0.02 | 0.03 | 0.1% |
| Other | 30% | 38% | 68% | 32% | 1.26 | 0.16 | 1.42 | 5.4% | 0.68 | 2.10 | 6.1% |
| | | | | | **21.54** | **4.97** | **26.51** | **100%** | **7.75** | **34.26** | **100%** |

**Self-assessment percentages based on 59% of thick dairy products, 28% of liquid dairy products and 12% of other dairy products (Steenhuisen 2019).*

*** Percentages for bread-based products. In practice, this will probably be lower than bread.*

**** Rice, pasta and couscous adjusted for water absorption.*

The amounts per product group are broken down in Table 4. The top 5 consists of bread, dairy products, vegetables, fruit and potatoes.

- Bread & bread-based products account for the largest share of total food waste, namely 21% (this was 22% in 2016; -1.9 kg pppy[14]). Pastry and cake were sorted separately and account for some 3%. In 2016, bread-based products were included with bread. These are bread-like products such as croutons, pizzas and wraps. Of the wasted bread, 15% consists of buns, 13% of unopened bread, 9% of crusts and 8% of sandwiches.
- Cheese (2%) and dairy products (15%) together account for 17%; the majority consists of thick liquid dairy products (yoghurt, custard, quark); a significant part of this type of products goes down the sink.
- 20% of food waste consists of fruit and vegetables, which is considerably less than in 2016 (26%): -2.0 kg vegetables and -1.8 kg fruit pppy.
- The largest drop is found in vegetables, namely -2.0 kg pppy (down from 5.7 to 3.7 kg).
- 8% of food waste consists of potatoes (77% prepared), one of the few product groups that has risen (0.4 kg pppy).
- 8% consists of sauces and fats, an increase of 1.1 kg (pppy). This figure was 4% in 2016 and 8% in 2013.
- Meat and meat products together account for 7%, showing a slight decrease of 0.6 kg pppy.
- Rice and pasta together account for 5% (up from 4% in 2016). For pasta, the waste has increased by 0.1 kg (pppy); it has decreased for rice by 0.1 kg. The majority consists of prepared pasta (75%) and rice (83%). This has been converted back to the dry product.[15]

The conclusion is that bread (including bread-based products) still accounts for the greatest share in solid food waste, followed by dairy products, vegetables, fruit and potatoes. Meat and meat products are no longer in the top 5, having made way for potatoes (both the waste and purchase of potatoes have increased). The largest absolute drop in food waste occurred in the following product groups:

1. vegetables - 2.0 kg
2. bread - 1.9 kg
3. fruit - 1.8 kg
4. dairy products - 1.7 kg
5. pastry & cake - 0.7 kg

## 3.4 Share of waste in relation to quantities purchased

To determine which part of the purchased solid food ends up in household waste, complete and reliable purchase figures are required. The food waste measurements in 2010 used estimates from various different sources, of which CBS was the most important. In 2013, 2016 and 2019, figures from market research firm GfK were used (Temminghoff 2019). GfK performs regular household surveys. Based on these figures, for each main category, it was determined how many kilos per person per year are purchased by consumers on average. In recent years, GfK has implemented a number of changes in the way population volumes are measured and calculated.[16] The purchased volume figures from 2013 and 2016 have been adjusted using the new measurement method, which means that the percentages of food waste compared to the quantities purchased are lower than in the 2016 report.

[14] Bread and bread-based products were a single group in 2016; they are now reported separately. These differences have not been tested for significance.
[15] In 2016, the conversion rate used was 100%. If this had been applied again, rice and pasta would have decreased by 0.5 kg, and the total amount of waste would also have been 0.5 kg less.
[16] This involves three points: refinement of the weighing method, including benchmarking with external sources; adjustment for the strong tendency of panel members to buy special offers; upgrading of smaller and forgotten shopping trips.

When considering the share of food waste in relation to purchases, we are looking at solid food, including sauces, fats and dairy products. Some sorted components were adjusted to allow them to be used with the purchase figures:
Coffee grounds and tea bags (8.8 kg) have been left out of the unavoidable losses because they are related to liquid waste. This leaves 15.7 kg of unavoidable solid food losses (see table).

*Table 6: Composition of unavoidable food waste*

| **Unavoidable** | **Total** |
|---|---|
| Peels and stalks | 11.8 |
| Wax rinds of cheese | 0.2 |
| Eggshells | 0.7 |
| Coffee grounds | 8.2 |
| Tea bags | 0.6 |
| Meat and fish remains | 1.2 |
| Fats | 0.0 |
| Unsortable | 1.8 |
| Total unavoidable | **24.5** |
| Coffee/tea adjustment | - 8.8 |
| Unavoidable (solid) | **15.7** |

During the preparation of some foods, weight loss (for example, evaporation of water when cooking vegetables and frying meat) or weight gain (for example, when cooking pasta) may occur. These effects are negligible for most waste streams.[17] Only pasta, couscous and rice have been adjusted for this, because they increase significantly in weight (by a factor of about 2.5 for rice and 1.8 for pasta) due to water absorption when cooking. Rice is the only product group whose purchase figures are not derived from the GfK figures (Temminghoff 2019), but from the consumption figures of the most recent Voedselconsumptiepeiling (VCP) [National Food Consumption Survey] of 2012–2016 (RIVM 2018).[18] For rice, this is 4.68 kg pppy converted to dry weight[19] (1 kg higher than the quantities purchased). This was done because, in contrast to the other product groups, a substantial portion of the rice consisted of out-of-home purchases of prepared rice for consumption at home. The same was seen during the waste composition analyses: a lot of the rice found was prepared takeaway rice in takeaway containers (Steenhuisen 2019).

[17] There are some exceptions to this, such as vegetables (e.g., spinach) that lose a very high amount of water when cooked, but these have not been reported separately.
[18] This was also done for pasta in 2016, but the current analysis shows that chow mein and noodles only constitute a small proportion of the pasta.
[19] The VCP indicates that 21.2% of the bread & cereals product group is consumed away from home. An adjustment has also been made for this.

*Table 7: Share of food waste (solid, avoidable) in kg per person relative to quantities purchased (2010, 2013, 2016 and 2019).*

| | 2010 | 2013 | 2016 | 2019 |
|---|---|---|---|---|
| Total purchased (excl. drinks, incl. dairy products) ** | 376 | 387 | 391 | 377 |
| Unavoidable loss | 22 | 19 | 21 | 16 |
| **Total edible** | **354** | **368** | **370** | **362** |
| | | | | |
| Waste from waste composition analysis* | 35 | 32 | 30 | 27 |
| Waste via other routes* | 13 | 15 | 10 | 8 |
| **Total waste*** | **48** | **47** | **41** | **34** |
| | | | | |
| %wastage vs avoidable | 13.6% | 12.8% | 11.1% | 9.5% |
| **Consumption** | **306** | **321** | **329** | **327** |

** Amounts adjusted for water absorption by rice and pasta.*
***Figures for 2013 and 2016 adjusted for GfK's new method.*

Table 7 gives an overview of kilos and weight percentages of the share of food waste, divided into avoidable and unavoidable waste, relative to purchased amounts. Table 5 also provides an estimate of the waste that occurs through routes other than household waste. These are calculated based on the figures from the self-assessment.

Waste via household waste – adjusted for water absorption by pasta and rice – is 26.5 kg pppy, and the above-mentioned calculated percentages of waste via other routes amount to 7.8 kg pppy. In total, Dutch consumers waste 9.5% of the solid food purchased.

Of the 377 kg pppy of solid food purchased by households (Temminghoff 2019), 50.0 kg is ultimately not consumed; 15.7 kg is unavoidable waste and 34.3 kg is avoidable waste. Indoor household consumption is therefore 377 – 50 = 327 kg. Of the solid, edible food (362 kg), 9.5% (34.3 kg) is wasted. This is less than the amount wasted in previous periods, 14% lower than in 2016 (11.1%).

*Table 8: Percentage of waste per product group relative to the amount bought per purchasing household (based on an average household of 2.19 persons).*

| Product group | Kg wasted pppy | Bought per purchasing person* | Percentage wasted per person |
|---|---|---|---|
| Meat and meat products | 2.30 | 71.58 | 7.0% |
| Fish | 0.25 | 7.69 | 7.2% |
| Cheese | 0.62 | 21.85 | 6.2% |
| Dairy products (excluding cheese and butter) | 5.14 | 82.41 | 13.6% |
| Eggs | 0.35 | 12.42 | 6.2% |
| Vegetables | 3.69 | 101.94 | 7.9% |
| Fruit | 2.97 | 95.42 | 6.8% |
| Potatoes | 2.87 | 49.92 | 12.6% |
| Bread (excluding pastry and cake) + bread-based products | 7.28 | 74.19 | 21.5% |
| Rice*** | 0.83 | 4.68 | 38.9% |
| Pasta*** | 1.04 | 5.87 | 34.1% |
| Sweets and snacks (excluding pastry and cake) | 0.81 | 38.49 | 4.6% |
| Sauces and fats (incl. butter) | 2.74 | 35.18 | 17.0% |
| Pastry and cake | 0.98 | 23.97 | 8.9% |
| Soup** | 0.03 | 8.06 | 0.9% |
| Sandwich toppings | 0.13 | 12.46 | 2.3% |
| Other categories (including leftovers from meals) | 2.20 | 58.25 | 8.3% |

** Percentage of amount bought adjusted for unavoidable losses.*
*** Part of the soup is bought in dried form and mixed with water. This percentage is therefore an overestimation, but insufficient data are available for an adjustment.*
**** Pasta and rice are adjusted for water by a factor of 1.8 and 2.5 respectively. No purchase data are available for rice, but the consumption data come from the 'Voedselconsumptiepeiling' [Food Consumption Survey] conducted in 2012–2016 (RIVM 2018).*

The trend in the share of waste greatly differs for different product groups, relative to the purchased quantity per household (Table 8). For example, the share is high for rice (39% in 2019, 34% in 2016) and pasta (34%, previously 23%). The increase is attributable to the adjusted calculation method. The same goes for bread (22%, previously 30%). Sauces and fats (17%) have increased since 2016 (previously 11%). Dairy products are at 14%. Potatoes are at 13% (previously 14%) and pastry & cake at 9% (previously 17%). In percentage terms, the largest reductions are found in vegetables (from 19 to 8%) and fruit (from 17 to 7%), followed by bread (from 30 to 22%). Consumers are therefore throwing relatively less fruit and vegetables away.

## 3.5 Liquid Waste Estimation Survey: mainly coffee and tea, but also dairy products

On average, 125 millilitres per day are wasted per person (excluding beer and wine, 121 ml). Coffee and tea account for the largest share, followed by dairy products. Converted to waste per year, based on this study, we estimate this at 45.5 litres, of which 23.2 litres of coffee and tea. Without beer and wine, this comes to 44.2 litres.

*Table 9: Estimated waste of liquids via toilet and sink per person per year (litres); total and by origin of the waste.*

| | **total** | **from glass/ cup*** | **from bulk packaging** |
|---|---|---|---|
| coffee/tea | 23.2 | 7.2 | 16.0 |
| milk/buttermilk | 7.2 | 2.6 | 4.6 |
| soft drinks/juices | 5.7 | 1.8 | 3.9 |
| thick dairy products | 3.8 | 1.2 | 2.5 |
| dairy drinks | 3.2 | 1.1 | 2.2 |
| sauces | 1.1 | 1.1 | |
| wine | 0.8 | 0.3 | 0.6 |
| beer | 0.4 | 0.2 | 0.2 |
| **total** | **45.5** | **15.4** | **30.0** |
| without wine and beer | 44.2 | | |
| dairy products | 14.2 | | |

** sauce in spoons*

Dairy products follow with 7.2 litres of milk, 3.2 litres of dairy drinks and 3.8 litres of thick dairy (yoghurt, custard, quark, etc.). The wastage of wine and beer was measured for the first time this year and appears to be low at 0.8 and 0.4 litres pppy. The total amounts of waste from beverages and thick liquids (dairy products and sauces) are 40.6 litres and 4.8 litres respectively. The total measured amount of liquids wasted via the sewer is significantly lower than in 2016, the first year in which the measurement was carried out (57.3 litres; -11.8 litres). If you do not count beer and wine in 2019, the difference is -13.1 litres. Across the board, the waste has fallen slightly. The amounts of wasted coffee & tea (-7.5 l) and milk (-3.0 l) have decreased in particular. Approximately two-thirds of the liquids come from bulk packaging and one third from glasses, cups or mugs (see Table 9).

- Most coffee and tea (more than two-thirds) is thrown away from a pot or can because there was too much or it no longer tasted good. Men throw away more coffee and tea than women.
- The main reason for throwing away milk is the untrustworthy smell, the appearance or the taste. When dairy products are discarded from the carton, the best-before date is the main reason for wasting it. The main reason for throwing away liquids from a glass is that it could not be finished..
- Thick dairy products are mainly discarded because the product was no longer needed or could not be finished.
- Soft drinks and juices are mainly thrown away from a bottle or carton because the product no longer tasted good.
- Little beer is thrown away; when it is, this is mainly because people no longer enjoyed the taste of the product.
- Wine is also rarely discarded. Wine is thrown away mainly because it cannot be finished.

When the results are broken down into subgroups, we see the following:

- Men waste more liquid than women, especially coffee and tea.
- People under the age of 30 in particular waste more liquid than average, mainly students and schoolchildren. Young people aged 25–29 are by far the most wasteful.
- Multi-person households under the age of 49 without children and single people under the age of 49 also waste more liquid than average.
- Although waste has fallen throughout the country, it has risen from 56.9 litres to 58.8 litres pppy in the three major municipalities (Amsterdam, Rotterdam and The Hague).
- There is little difference between educational levels, except that more highly educated people waste more wine than the rest of the Netherlands (1.4 litres versus 0.7 litres pppy). More highly educated people throw away half as much dairy beverages as people with lower levels of education.

In relation to the quantities bought per purchasing household, the waste of beverages (excluding dairy products) is about 6.4% (see Table 10).

*Table 10: Percentage of beverages wasted in relation to quantity bought*

| | **% wasted** |
|---|---|
| Coffee and tea* | 13.7% |
| Non-alcoholic beverages (soft drinks/juice) | 5.8% |
| Alcoholic beverages (wine and beer) | 2.6% |
| **Total average** | **6.4%** |

**Assumption of 7g coffee per cup and 2g tea per cup (150 ml) with a 50/50 distribution.*

## 3.6 Waste fed to animals: mainly bread and bread-based products

By extrapolating the waste composition analysis with the waste route ratios from the self-assessment, we arrive at an estimate of waste fed to animals. This is 2.1 kg per year. This mainly concerns pets and other animals outdoors, such as ducks and birds and animals at the petting farm, so not livestock. This mainly involves bread & bread-based products, 1.3 kg. Some vegetables, fruit and dairy are also given to animals. If we do not count this, in accordance with the FUSIONS manual (Tostivint et al. 2016), then the food waste in the Netherlands is 32.2 kg pppy.

Only 1.0 kg pppy of food is discarded via other routes. The compost heap and other routes (such as public rubbish bins) are mainly used to dispose of sauces, potatoes, vegetables and bread.

# 4. Discussion

## 4.1 Self-assessment results in underestimation

Research has shown that self-assessment via diaries or questionnaires leads to under-reporting in comparison with waste composition analyses (Høj 2011). Relying on recall methods entails a susceptibility to errors, which means such the uncertainty associated with these data should be clearly explained. Since the accuracy of the figures will be lower than with other methods, an organisation should not use the data for more than a general understanding of the amounts of food wasted (Tostivint et al. 2016).

Respondents were asked how often they throw away particular products. The descending scale of frequency went through seven steps, from 'almost every day' to 'never'. An annual frequency was added to each of the product categories. After all, there is a significant difference between entering 'every day' and 'a few times a week', namely, a factor of two, making it a fairly rough estimate. Subsequently, respondents were asked how much they think they throw away of each product each time. The products that were discarded were given an ascending scale, starting with 'a few bites' up to 'a kilo', or a similar large amount fitting the category. The respondents therefore themselves estimate how much they are wasting.

Their own estimate is an average of 11.4 kg of solid food (11.6 in 2016) and 6.9 litres of liquid (9.6 in 2016). 3.1 kg of this is thick liquid. This 14.5 kg (11.4 + 3.1) is almost half the figure from the waste composition analysis (26.5 kg). The group that entered 'never' largely determined the low average, but the waste composition analysis revealed that every household throws things away. Self-assessment therefore results in underestimation.

We have deliberately chosen to continue using a low-threshold and fast method of questioning. The disadvantage of this is that the estimate is less accurate. For the time being, using this method to examine the proportions and follow the trends over a period of time is sufficient.

The EC recognises diaries as a suitable method of measuring waste. This method is described as a natural person or group of people regularly updating a register or logbook of information on food waste (EC 2019). In food consumption studies, it is customary to use a frequency questionnaire instead of a diary. Although these questionnaires have advantages and disadvantages, a frequency questionnaire was still chosen this time to ensure comparability with 2016, combined with usual quantities.[20]

Ideally, waste would be calculated based on a waste composition analysis and then combined with information obtained from questionnaires. A questionnaire can also be used if an organisation is looking for possible effective interventions for reducing waste and wishes to gain insight into behaviour, attitudes and values that go hand in hand with specific quantities and types of food waste (Tostivint et al. 2016).

[20] ('Could you indicate how often you throw away the following products?' x 'What amount do you usually throw away each time?')

## 4.2 Estimated waste via PMD

The European Commission's new proposal states that the measurement of food waste shall not cover [...] food waste residues collected within packaging waste classified under waste code "15 01 – Packaging (including separately collected municipal packaging waste)" (EC 2019). Any remains in separately collected PMD waste are therefore not included in the national figure. In this section, we nonetheless estimate the amount of food waste via PMD waste in order to estimate whether much is wasted via that route.

The Learning Center Kunststof Verpakkingsafval [Learning Center for Plastic Packaging Waste] has conducted a study on the composition of collected plastic/PMD packaging (Eijsbouts et al. 2018). A total of 422 samples with a total weight of 14,982 kg were taken:

- 9,275 kg consisted of plastic packaging with contents of 237 kg, or 2.6%.
- 827 kg consisted of metal packaging with contents of 5 kg.
- 1,641 kg consisted of drink cartons with contents of 25 kg.

This adds up to 11,743 kg of pure PMD, containing 267 kg of contents. Assuming that all contents of the packages consist of food, the proportion of food remains (267 kg) in relation to the total weight of the samples (14,982 kg) (so including non-PMD) is between 1.78 and 2.27%. According to CBS (Gemeentelijke afvalstoffen; hoeveelheden, Gemeentelijk afval (in kg per inwoner), PMD-fractie, 2018 [Municipal Waste; Quantities, Municipal Waste (in kg per inhabitant), PMD fraction, 2018]), there is an average of 15 kg PMD per inhabitant. This would mean that the possible food waste pppy could be between 0.3 and 0.4 kg at maximum.

We cannot assume that all contents consist of food remains or that all food remains are also food waste (the actual weight will therefore be lower), but the above does provide an idea of the (modest) extent of this form of waste. It would not be cost-effective or necessary in accordance with EC rules to measure this separately.

## 4.3 Estimated waste via oils and fats collected separately

Of the group of sauces and fats measured in the waste composition analysis, part consists of edible oil. Separately collected oils and fats have not been measured in any other way. According to CBS (Gemeentelijke afvalstoffen; hoeveelheden – frituurvet en -olie [Municipal Wastes; Quantities – Frying Fat and Oil]) (CBS 2019), the quantity of separately collected oil and fat for the period 2013–2018 remains unchanged at 0.1 kg per person per year. This is low. This is likely mostly made up of deep-frying oil and fat. Based on these figures, we cannot distinguish between edible oil (avoidable) and frying oil (unavoidable).

## 4.4 Differences between avoidable and unavoidable are not always clear-cut

WUR provides a definition of unavoidable waste: 'Food waste is unavoidable if it is not a by-product and is not edible or usable for human consumption.' (Soethoudt and Timmermans, 2013). Unavoidable food remains are food remains that are not normally directly suitable for consumption, such as peels, bones, etc. However, some of these unavoidable food remains are perfectly edible, such as broccoli stems and peels from apples, pears and cucumbers, for example. There is also a potentially avoidable category, and it is not always clear in which category some products fall; in principle, broccoli stems are edible, but they could also be counted as peels and stems. CREM Waste Management has looked specifically at this. This category of 'edible unavoidable food remains' accounts for approximately 0.3% of total residual waste and 0.2% of total VFG waste. Converted to weights, the amount of edible unavoidable food remains is small: about 0.7 kg pppy (0.5 kg in residual waste and 0.2 kg in VFG waste).

In the method used, part of the unavoidable waste is regarded as avoidable if it forms part of the product, such as apples with cores, eggs with shells, cheese with rinds and meat with bones. This has therefore not been adjusted.

## 4.5 Demographic trends paint a varied picture

The amount of waste is related to household demography (Derksen and Aardening 2019). A brief analysis of demographic trends between 2010 and 2019 was therefore carried out. CBS has figures available up to and including 2018 (Table 11). The demographic trends paint a varied picture. Comparing the self-assessment results shows that some trends may lead to more waste, while others may result in less waste (Derksen and Aardening 2019). However, there is another study that sometimes draws different conclusions than those from the self-assessment (Van Dooren and Mensink 2018). We must therefore be cautious when it comes to drawing hard conclusions. For example, the number of single-person households is increasing (less waste is expected) and the number of families with young children is decreasing slightly (once again, less waste is expected). Increasing incomes and possibly the level of educational attainment may have led to more waste, while the decreasing average household size may have led to less waste per person. The age trends over this period are fairly stable, although the number of people over the age of 65 is increasing. Ageing may lead to less waste. A number of demographic trends may therefore have contributed to a reduction in waste, while a number of developments also point in the other direction. The figures have not been adjusted for demographic developments other than the growth of the total population.

*Table 11. Demographic developments 2010–2018 (CBS 2019)*

| **Demographics (CBS)** | | **2010** | **2013** | **2016** | **2018** | **Trend with potential effect on waste** |
|---|---|---|---|---|---|---|
| population | million | 15.864 | 16.780 | 16.979 | 17.181 | increasing |
| household size | | 2.22 | 2.19 | 2.17 | 2.19 | decreasing |
| total number of households | million | 7.386 | 7.569 | 7.721 | 7.858 | increasing |
| composition (ageing) | | | | | | |
| below the age of 20 | percent | 25.7 | 25.1 | 22.5 | 22.2 | |
| 20 to 40 year | | 25.3 | 24.6 | 24.5 | 24.8 | decreased until 2013 |
| 40 to 65 year | | 35.7 | 35.5 | 34.8 | 34.2 | |
| 65 to 80 year | | 11.4 | 12.6 | 13.8 | 14.5 | |
| 80 year and above | | 3.9 | 4.2 | 4.4 | 4.5 | |
| above 65 year | | 15.3 | 16.8 | 18.2 | 19.0 | increasing |
| | | | | | | |
| number of single-person households | thousand | 2.670 | 2.802 | 2.906 | 2.998 | increasing |
| two-person households | | 2.418 | 2.475 | 2.530 | 2.565 | |
| three-person households | | 908 | 914 | 925 | 930 | |
| four-person households | | 971 | 968 | 959 | 960 | |
| five-person+ households | | 421 | 410 | 400 | 405 | |
| families with young children <5 y | | 494 | 488 | 477 | 466 | decreasing slightly |
| multi-person, adults only | | 2.182 | 2.203 | 2.236 | 2.265 | increasing slightly |
| | | | | | | |
| low level of education | thousand | 4.781 | 4.494 | 4.522 | 4.438 | |
| medium level of education | | 5.125 | 5.374 | 5.371 | 5.423 | |
| high level of education | | 3.446 | 3.619 | 3.898 | 4.165 | increasing |
| unknown | | 104 | 266 | 199 | 205 | |
| | | | | | | |
| income (average standardised) | euros | | 16.430 | 16.595 | 16.702 | increasing |
| people with low income | thousand | | 7.400 | 6.500 | 6.600 | |
| | | | | | | |
| urbanisation (three major municipalities) | million | 1.849 | 1.921 | 1.983 | 2.025 | increasing |

## 4.6 Decrease in purchase volume not the main cause of less waste

If you compare the purchase volumes in 2019 with 2016 and 2013, it can be concluded that the volumes per purchasing household have decreased in many categories. The biggest decreases are found for potatoes, soup, fish, bread, sauces & fats, meat and liquid dairy products. However, purchases of a number of product groups are increasing, including thick dairy products, eggs, rice, vegetables and sweets & snacks. The total decrease in purchase volume is 3.5% compared to 2010, 2.5% compared to 2013 and 3.6% compared to 2016. Compared with six years ago, households are therefore purchasing a slightly lower volume for in-house consumption (in kg). The reasons for this may lie in the demographic trends, as mentioned in Section 6.5. These include an increase in the number of smaller households and older households (ageing). There may also be more consumption outside the home or more use of meal delivery services. The decrease in the purchase volume can therefore only explain a very small percentage of the decrease in measured waste (3.5% of the 29%). This is also reflected in the magnitude of the change in the percentage of food waste compared to the amount purchased, from 12.8% in 2013 to 9.5% today. The decrease in purchase volume is not the main cause of less waste, which means other factors are involved.

## 4.7 Interventions may contribute to the decrease

In the period 2010 to date, there have been many interventions aimed at reducing food waste in households. Awareness of food waste has grown considerably as a result of information campaigns (Temminghoff and Van Helden 2018). For example, the sharp decline in the waste in fruit and vegetables could be linked to the greater choice of smaller portions in supermarkets, longer shelf life due to improved packaging material and better information on storage methods for fruit and vegetables. Generally speaking, interventions cannot be linked directly to results, but efforts to inform and interventions may have contributed to the measured reduction in food waste.

## 4.8 Results per person or per household?

When comparing the results for liquids for 2019 with those for 2016, a deliberately chosen change in the study design must be taken into account. Nevertheless, the results from the various years can be compared well. The waste volumes were reported per person in the Liquid Waste Estimation Survey in 2019. The waste per 'housekeeper' was requested in 2016. In 2016, we assumed the following: people often eat and drink together with their family or housemates. For this reason, waste is likely to be the result of the actions of multiple people within the household. Activities such as clearing the table or throwing away products that are in the refrigerator are often done by a person on behalf of the other household members. In 2016, we asked the 'housekeeper' to report the waste via the sink and toilet for the entire household. When interpreting the research results and comparing the liquid waste with the figures for solid food waste, we found that we were missing figures on liquid waste at a personal level. In the 2019 measurement, we therefore specifically asked for the waste per person. Everyone was asked to specify just their own personal waste. For participants under the age of 16, an authorised parent was invited to chart the waste for the child alone. Using this method, we think we have gained a better picture of the waste per person. However, we cannot completely rule out the possibility that respondents also threw away drinks for other people within a household in 2019.

In order to enable an overall comparison of liquid waste between 2016 and 2019 despite the change in research methodology, you could compare the waste figures for 2019 with the waste figures for single-person households from 2016. In single-person households, we can assume that the reported waste is for one person. The waste in single-person households was lower in 2019 than in 2016, from 53.7 l in 2016 to 46.2 l in 2019 (excluding beer and wine). Although this decrease is significant, it is smaller than the average decrease for all households. In 2016, the amount of liquids wasted by the housekeeper in an average household was 3.7 l more than in a single-person household: 53.7 l. In 2016, it appeared that the bigger the household, the more liquid was wasted. This effect in large households is no longer found. The 46.2 litres/year for single-person households in 2019 barely deviates from the average of 45.5 litres, indicating that multi-person households also reported per person.

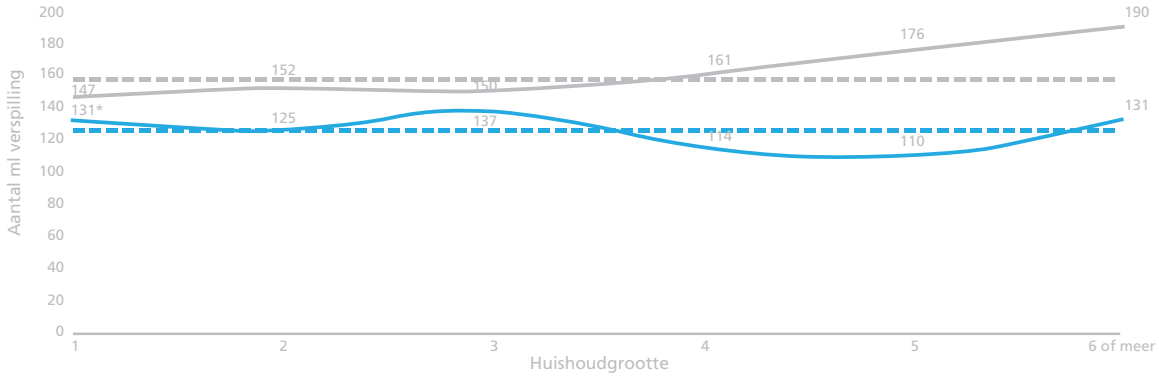



*Figure 4: Distribution of drinks waste (2016, 2019) by household size (Kaal and Hooijmans 2019).*

## 4.9 Differences in samples

The samples taken in the three studies do not overlap completely in terms of the study population. A selection of representative municipalities and districts was made in the waste composition analysis, with a substantiated assumption (Rijkswaterstaat 2016) as regards the representativeness for the population as a whole (i.e. including children). The self-assessment study was conducted among Dutch people over the age of 18 (i.e. excluding children). The sample was stratified by age, gender, education and provincial income, three largest municipalities and household composition. In the Liquid Waste Estimation Survey, the sample was a representative sample of the entire Dutch population based on gender, age, region, household size and education. In order to arrive at a conclusion per person, one of the authorised parents was invited to act on behalf of respondents under the age of 16. They conducted the survey on behalf of their child. The synthesis is based on the assumption that the three studies represent the entire Dutch population, although no children under the age of 18 were included in the self-assessment. Children under the age of 12 eat less and differently than adults (RIVM 2018). Given the same percentage of waste per route, children are expected to waste less food in absolute quantities.

## 4.10 Measuring liquids

We have mapped liquid waste in three ways:

- Self-assessment
- Extrapolation of figures from the waste composition analysis to other waste routes based on ratios of waste routes as measured in the self-assessment
- Liquid Waste Estimation Survey

All three research methods gave a different picture of the amount of liquid waste.
The self-assessment provides a total of 3.8 litres of drinks pppy. The Liquid Waste Estimation Survey is more than 10 times as high at 45.5 l pppy. The self-assessment provides an underestimation (see 6.1).
The self-assessment shows that the main route for liquid waste is sinks (83%) and toilets (4%).
The self-assessment also indicates that 8.5% of the liquids are disposed of via residual waste and 2.5% via VFG waste (as well as 2% via the remaining routes).[21]

In line with the methods recommended by the EC (EC 2019) and FUSIONS (Tostivint et al. 2016), a decision was made to report the figures from the Liquid Waste Estimation Survey separately, with the exception of dairy products and thick liquids, which are included in the waste composition analysis. Since dairy products and thick liquids are found in residual waste to a significant extent, we provide two figures for this (see Figure 1). We feel that the Liquid Waste Estimation Survey provides the most reliable and realistic figure for liquid waste at the present time.

For dairy products, the proportion of waste via waste bins is higher than for other liquids: 15% for liquid dairy products and 37% for thick dairy products. For sauces, the proportion is 80%, for fats 61% and for soups 29%. It is therefore a good decision to also look at dairy products and other thick liquids, such as sauces, soups and fats, in the waste composition analysis.

*Table 12: Waste of solid food, thick liquid and dairy products via other routes (figures obtained by extrapolation) (kg pppy).*

| | **sink & oilet** | **animals** | **other** |
|---|---|---|---|
| Meat | | 0.1 | |
| Meat products | | | |
| Fish | | | |
| Cheese | | | |
| Dairy products | 3.4 | | |
| Eggs | | | |
| Vegetables | | 0.1 | 0.1 |
| Fruit | | 0.2 | |
| Potatoes | | 0.1 | 0.1 |
| Bread | | 1.1 | 0.1 |
| Pastry and cake | | | |
| Bread-based products | | 0.2 | |
| Rice | | 0.1 | |
| Pasta, couscous | | | |
| Sweets, chocolate and snacks | | | |
| Sweet and savoury spreads | | | |
| Sauces and fats | 0.6 | | 0.3 |
| Soup | | | |
| Other & leftovers from meals | 0.5 | 0.1 | 0.1 |
| **Total** | **4.7** | **2.0** | **0.9** |

[21] One possible reason could be that respondents mistakenly regarded coffee grounds and tea bags as avoidable food waste.

Based on extrapolation, we estimate the waste of liquid and thick dairy products at 3.4 kg via other routes and of sauces and fats at 0.9 kg. Of these, consumers wasted 3.4 and 0.6 kg respectively via the sink and toilet (see Table 12). It is striking that the self-assessment reports 10% thick dairy products in VFG, while no dairy whatsoever (recognisable as such) was found in VFG during the waste composition analysis. The same applies to soups (15%) and sauces (17%).

The Liquid Waste Estimation Survey gives higher figures for the sink and toilet (3.8 l thick dairy products, 3.2 l dairy drinks and 7.2 l milk). However, the estimate for fats and oil is in the same order at 1.1 l. The total amount of dairy products wasted based on the Liquid Waste Estimation Survey is 14.2 l, more than four times higher than the extrapolation of the waste composition analysis and five times higher than the self-assessment (2.6 l). It is therefore difficult to extrapolate a clear figure for dairy products waste based on the waste composition analysis and the Liquid Waste Estimation Survey. Both figures are reported. Since the figure from the waste composition analysis also includes dairy products and thick liquids, the results of the two studies cannot simply be added together.

## 4.11 Establishing reliability and significance

IIn the waste composition analysis, confidence margins were used to examine whether there is a significant difference (Table 13). The statistical analysis proposed by Rijkswaterstaat was followed here (Rijkswaterstaat 2016). The table shows the average plus and minus twice the standard deviation (SD) as the maximum and minimum. For the first time, these margins for kg measured in the waste composition analysis no longer overlap between 2019 and 2010. If we follow the Rijkswaterstaat protocol, this decrease is statistically reliable. There is still an overlap between 2019 and 2016. However, according to the supervisory committee, there are comments to be made on the chosen assumptions and test. In a subsequent measurement, this will be examined retroactively with a more accurate statistical test.

One of the causes of the high confidence interval is that the variation in the amount of food waste between households and municipalities is very large and the sample is very small. The variability over time within the same municipality is also high.

*Table 13: Confidence intervals for waste composition analysis (average +/- 2SD).*

| | kg pppy | | | |
|---|---|---|---|---|
| | **2010** | **2013** | **2016** | **2019** |
| maximum (+ 2SD) | 38.7 | 36.6 | 33.7 | 30.1 |
| **average** | **34.6** | **32.2** | **30.4** | **26.5** |
| minimum (- 2SD) | 30.5 | 27.8 | 27.1 | 22.9 |

The statistical testing between 2016 and 2019 for the Liquid Waste Estimation Survey and the self-assessment was carried out by the research agencies. The decrease in liquids appears significant, while the decrease in the self-assessment does not (t-test, $p<0.05$).

*Table 14: Waste via other routes (in kg pppy)*

| | 2010 | 2013 | 2016 | 2019 |
|---|---|---|---|---|
| Other routes kg pppy | 13.4 | 15.2 | 10.8 | 7.8 |

Part of the decrease compared to previous studies is due to the relatively uncertain estimation of other routes by consumers; consumers are providing a lower estimate of their waste via other routes than in previous years. This method has not been validated. The estimate is currently 7.8 kg (Table 14). This figure was 13.4 kg in 2010, 15.2 kg in 2013 and 10.8 kg (-3.0 kg) in 2016. Confidence intervals are known for the total self-assessment: +/- 3.2 kg for 2019 and +/- 3.1 kg for 2016 (Derksen and Aardening 2019). As a result of this large margin, we cannot claim that waste via other routes has fallen significantly.

## 4.12 Methodological explanation for the decrease in food waste

Based on the methodology and calculations used, four explanations can be given immediately for the reduction in food waste:

1. In the waste composition analysis, the waste was calculated as a percentage of the amount of residual and VFG waste. The amount of residual waste for the whole of the Netherlands decreased autonomously between 2010 and the present day. The amount of VFG waste increased, but the combined amount of waste decreased by 11%. This may be attributed to general policies in the areas of waste prevention and separation.
2. The number of inhabitants in the Netherlands increased from 16.6 million to 17.2 million between 2010 and 2018, reducing the waste per person.
3. The percentage of food waste in residual waste and VFG waste decreased between 2016 and 2019. It went from 13.9% to 13.1% of residual waste and from 6.1% to 5.9% of VFG waste. This may be due to the policy aimed at reducing food waste.
4. Based on the self-assessment, consumers estimate that they discard less in percentage terms via routes other than residual and VFG waste. The percentage that is discarded via other routes (32%) is lower than in 2016 (40%). This results in lower figures for the extrapolation and reduces the final total figure. If food is wasted, this appears to take place relatively less often by flushing it down the toilet or sink, feeding it to animals or composting it.

## 4.13 Relationship with the 'Monitor Voedselverspilling' [Food Waste Monitor] (WUR)

Since 2009, Wageningen UR Food & Biobased Research has been monitoring food waste annually in the 'Monitor Voedselverspilling'. The last monitor is from 2017 (Soethoudt and Vollebregt 2019). The Monitor is concerned with food waste over the entire chain (i.e. from the agricultural phase to the consumer) at the macro level (albeit recalculated to residents). All residual waste streams are taken into account in the Monitor and all manner of sources are consulted to ascertain which of these derive from the food chain, including a breakdown into avoidable and unavoidable.

The total quantity of food waste in the Netherlands in 2017 throughout the entire chain was between min. 1,814 and max. 2,509 kilotons. Converted per capita, this works out at between 106 and 147 kg per person. In 2017, the upper and lower limits hardly changed compared to 2016 (147 kg compared to 145 kg and 106 to 105 kg respectively). The general picture that emerges from the Food Waste Monitor is that not much changed in the amount of food wasted in the entire chain between the years 2009 and 2017. This report is only about waste from households, and is furthermore measured differently. If we estimate solid food waste in households (excluding beverages) at around 34.3 kg, this means that households are responsible for a share of around 23% to 32% of the total waste in the chain.[22]

The European FUSIONS project reports that at EU level, 53% of food losses in the entire chain take place among consumers and that about 60% of these losses (32%) consist of avoidable waste (Stenmarck et al. 2016). This is therefore in the same range.

## 4.14 Suggestions for further research

The supervisory committee recommends repeating this study in three years' time to examine whether the declining trend is continuing and whether the policy objectives are being achieved. Suggestions for further research include:

- Developing a method of making the self-assessment more accurate and validating it more accurately;
- Developing accurate statistical verification of trends over time;
- Enlarging the sample size in the waste composition analysis to increase reliability; further investigating whether the analysis could be accelerated and improved by working with smart photo recognition;
- Calculating climate impact and climate gains through less waste based on the results;
- Exploring the monitoring of food waste via PMD;
- Comparing the chosen method with the methodology and results in other European countries.

[22] The most recent Monitor is from 2017, meaning that household waste in 2019 can only be related to data from a different year.

# Appendix:
# European agreements on food waste research

In the EU, a proposal was adopted in 2019 to require Member States to take appropriate measures to ensure the reliability and accuracy of food waste measurements. In particular, Member States must ensure that the measurements are based on a representative sample and are representative of the variations in the data on the amounts of food waste to be measured, and the measurements must be based on the best available information (EC 2019).

The Food Waste Monitor includes various streams as food waste across the entire chain: animal feed, fermentation, composting, incineration, landfill & discharge (Bos-Brouwers et al. 2015). The EU defines three waste routes that are applicable to households:

- biodegradable kitchen and canteen waste;
- edible oil and fat;
- mixed municipal waste.

For biodegradable kitchen and canteen waste, we use the term VFG (green); for mixed municipal waste, we use the term residual waste (grey). Please note that the edible oils and fats that are collected separately at waste sorting stations are not included in this study.

The EU prescribes establishing the amount of food waste by measuring the amount of food waste produced by a sample of households according to one of the following methods, or a combination of these methods or another method that is equivalent in terms of relevance, representativeness and reliability (EC 2019).

- Scanning/counting: assessment of the number of items that make up food waste, and use of the result to determine the mass.
- Waste composition analysis: physical separation of food waste from other fractions in order to determine the mass of the fractions sorted out.
- Diaries: an individual or group of individuals keeps a record or log of food waste information on a regular basis (EC 2019).

For this study, the second method – waste composition analysis – was used as the primary method. Additional information was collected using the third method (diaries).

*'There are several types of food, which are usually discarded as or with wastewater, such as bottled drinking and mineral water, beverages and other liquids. There are currently no methods for measuring such waste which would ensure sufficient levels of confidence and comparability of reported data. Therefore, such types of food should not be measured as food waste. However, MS should have the possibility to report information on these types of food on a voluntary basis.'* (EC 2019). The information on liquids is therefore provided as additional information in this report. In addition, all beverages (except dairy products) are excluded from the waste composition analysis.

To ensure that the methodology is practicable and that the costs and effort required for the monitoring are proportionate and reasonable, certain waste streams that are expected to contain no or negligible amounts of food waste should not be measured as food waste (EC 2019). Food waste via PMD waste and separately collected oils and fats have therefore not been measured.

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Colophon


Netherlands Nutrition Centre – honest about food

The Netherlands Nutrition Centre (Voedingscentrum) provides information on, and encourages consumers to make, healthier and more sustainable choices about food.

Author: Corné van Dooren, Netherlands Nutrition Centre
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www.voedingscentrum.nl