

Supplementary memorandum
Food waste
in Dutch households in 2016



Contents

Summary

Summary	3
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1. Introduction

1.1 Synthesis of three studies	5
1.2 Research objectives	6
1.2.1 Self-assessment	6
1.2.2 Household waste composition analysis (solid)	6
1.2.3 Liquid Waste Estimation Survey	6
1.3 Definition of 'food waste'	7
1.4 Study design	7

2. Methods

2.1 Self-assessment	8
2.2 Household waste composition analysis (solid)	9
2.3 Liquid Waste Estimation Survey	10
2.4 Purchase of food by households	10

3. Results

3.1 Self-assessment	11
3.1.1 Disposal routes in percentages: household waste, vegetable, fruit & garden waste (VFG waste), and sinks top of the list	11
3.1.2 Determinants of wastage found (self-assessment)	12
3.1.3 Waste frequency is decreasing (self-assessment)	12
3.2 Household waste composition analysis (solid): downward trend	13
3.3 Integration of results of the self-assessment and composition analysis (solid)	14
3.4 Share of waste in relation to quantities purchased	15
3.5 Liquid Waste Estimation Survey: mainly coffee and tea, but also dairy products	17

4. Discussion

4.1 Self-assessment results in underestimation	18
4.2 Results per person or per household?	18
4.3 Studies on beverage waste paint a varied picture	19
4.4 Decrease in purchase volume may be a cause of less waste	19
4.5 Establishing reliability	19
4.6 Relationship with the ' <i>Monitor Voedselverliezen</i> ' [Food Waste Monitor] (WUR)	20
4.7 Suggestions for further research	21

Colophon	22
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Summary

- Dutch households wasted an average of 41 kg of food per person in solid food (including sauces, fats and dairy products) in 2016.
- This seems to be a declining trend (–13 to –15%) compared to 2013 (47 kg) and 2010 (48 kg), but the measured decline is not significant.
- 13.0% of purchased food is wasted.
- Bread, dairy products, vegetables, fruit and meat are wasted most.
- 57 litres of drinks per respondent disappear down the sink or toilet every year.

At the end of 2016, the Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs commissioned a study on food waste in households in the Netherlands. Studies were also conducted in 2010 and 2013. In 2016, CREM Waste Management conducted a composition analysis of solid household waste from 130 households in 13 municipalities. Kantar Public conducted the consumer survey 'Voedselverspilling in Nederland op basis van zelfrapportage' ['Food waste in the Netherlands based on self-assessment'] among 763 respondents. In addition, Kantar Public, commissioned by the dairy industry and the Dutch Food Industry Federation [*Federatie Nederlandse Levensmiddelen Industrie, FNLI*], performed an estimation survey on the waste of liquids among 1,105 respondents via an app. Figure 1 provides a summary of the results.

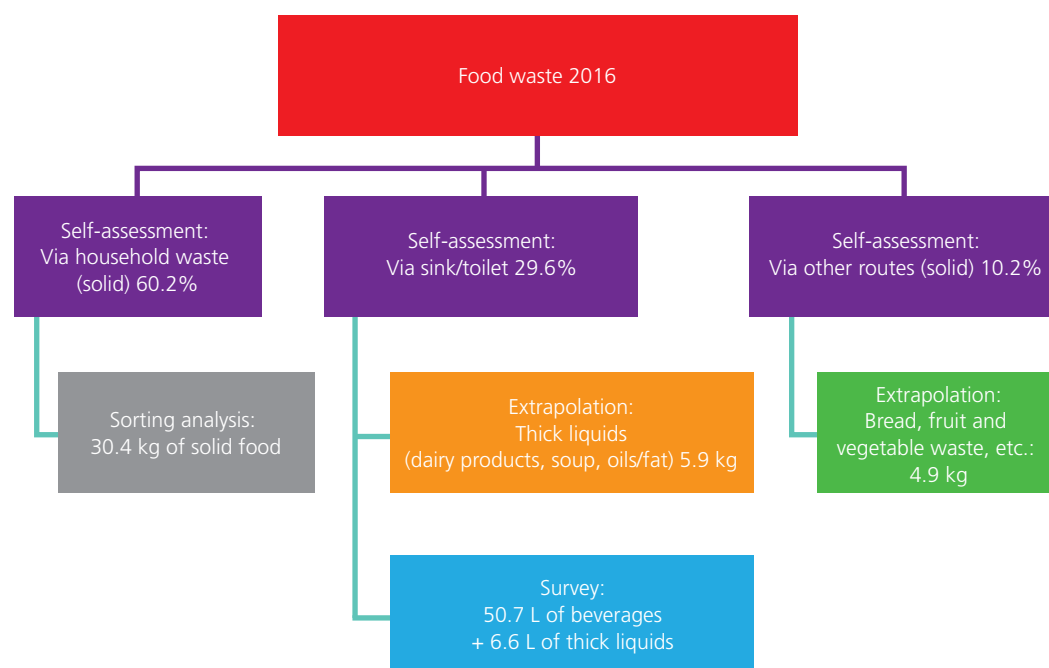


Figure 1: Estimation of food waste in Dutch households in 2016 via self-assessment (distribution routes in percentages: purple), composition analysis of solid household waste (kilos: grey), extrapolation of composition analysis based on percentages in the self-assessment (orange and green) and estimation of liquids via sewage system and toilets (litres: blue).

According to the self-assessment, consumers throw away 21.2 kilos of food (solid and liquid) per respondent, per year. Based on the results of the composition analysis, this appears to be an underestimation (41.2 kg). However, the self-assessment provides insight into the ways in which food is wasted. The main part is discarded via household waste: 60.2% (of which 35.0% via rubbish bag/bins and 25.2% via vegetable, fruit and garden (VFG) waste; see Figure 1). 29.6% goes down the sink or toilet (drinks and semi-solid / liquid products) and 10.2% via other routes (e.g. to animals and compost heaps).

The composition analysis shows that solid food waste (including sauces, fats and dairy products) via household waste amounts to 30.4 kilo per person, per year (grey box in Figure 1). Based on the distribution across the various routes, it has been calculated that 10.8 kg of solid food is wasted via other routes (5.9 kg of thick liquids and 4.9 kg of bread, fruit and vegetable waste, etc.). Together, that is 41.2 kilos per person, per year. This figure has been adjusted for water absorption by pasta and rice. It was less than the 48 kilos measured in 2010, and 47 kilos in 2013. However, this difference is within the confidence margin, meaning the decrease is not significant.

Solid food waste accounts for 13.0% of the amount of food purchased. In 2013, this was 13.5%. The most wasted solid foods are bread (23% of total waste; see Table 1), dairy products (custard, yoghurt, quark, milk: 17%), vegetables (14%), fruit (12%) and meat (7%). In 2013, the top 5 comprised dairy products, bread, vegetables, fruit, and sauces and fats, respectively.

What is new is that a new method has been used to estimate liquid waste via sinks and toilets (blue box in Figure 1). This amounts to 57.3 litres per person, per year: 50.7 litres of beverages (including 10.2 litres of milk and 2.6 litres of dairy beverages) and 6.6 litres of thick liquids (thick dairy products and sauces). This means that dairy products and sauces are measured in two ways. Waste volumes for coffee and tea (30.7 litres) and milk (10.2 litres) are especially large.

Solid food waste (including sauces, fats and dairy products) in households through household waste and other routes is thus 41.2 kilos per person, per year, and shows a non-significant, downward trend. The estimated wastage of beverages via sinks is 57.3 litres per respondent – a waste route that has thus far been underestimated. These figures cannot be added together because of the different measurement methods and units of measurement (per person, versus per respondent) used.

Most wasted solid foods in 2016

Top 10	Absolute waste per product group (kg PPPY and % of total waste)	Top 10	Relative waste per product group (% waste of purchased quantity) ^{a)}
1	Bread 9.2 22%	1	Rice ^{b)} 34%
2	Dairy products 6.8 17%	2	Bread 30%
3	Vegetables 5.7 14%	3	Pasta ^{b)} 23%
4	Fruit 4.8 12%	4	Vegetables 19%
5	Meat 2.9 7%	5	Pastry and cake 17%
6	Potatoes 2.5 6%	6	Fruit 17%
7	Pastry and cake 1.7 4%	7	Potatoes 14%
8	Sauces and fats 1.6 4%	8	Sauces and fats 11%
9	Pasta 0.9 2%	9	Meat and meat products 10%
10	Rice 0.9 2%	10	Cheese 9%

Table 1: Most wasted solid foods in 2016 (both absolute and relative)

Please note: rounded numbers

a) Calculated for the edible portion of the product.

b) Adjusted for water absorption during cooking (% of dry product as purchased).

1. Introduction

The total quantity of food waste in the Netherlands in 2012 was between 1.7 and 2.6 billion kg. Consumers account for 38% of all food waste and, as such, are the biggest wasters.¹ Therefore, it is important to find solutions that are relevant to consumers and will help them adjust their behaviour. In the Netherlands, consumers wasted about 47 kilos of solid food per person, per year in 2013. In monetary terms, this is more than € 150. Solid food includes sauces, fats and dairy products, but excludes beverages. Of those 47 kilos, 32 kilos disappeared via household waste, and an estimated 15 kilos via alternative routes.

The 2009 report on sustainable food of the Ministry of Agriculture, Nature and Food Quality [LNV], the Ministry of Housing, Spatial Planning and the Environment [VROM] and the Ministry of Health, Welfare and Sport [VWS] aimed to reduce food waste in 2015 by 20% compared with 2009. The Ministry of Economic Affairs and the Ministry of Infrastructure and the Environment see reducing food waste by consumers as a critical issue. For the Ministry of Infrastructure and Environment, it is one of the components of the policy to reduce household waste. One of the objectives of the UN Sustainable Development Goals (SDG 12.3) is halving per capita global food waste at the retail and consumer level by 2030 compared to 2015. To reduce food waste at the level of consumption, the EU has joined as well. The Netherlands also endorses this objective.

To monitor these objectives, it is important to measure progress on a regular basis. To that end, it was decided to conduct a new food waste study among households in the Netherlands at the end of 2016.

1.1 Synthesis of three studies

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

1. Manuel Kaal, Sabine Hooijmans & Iris Houtepen (14 February 2017), *'Voedselverspilling in Nederland op basis van zelfrapportage'* [Food waste in the Netherlands based on self-assessment], Kantar Public, Amsterdam.
2. Frits Steenhuisen (March 2017), *'Bepaling voedselverspilling in huishoudelijk afval Nederland 2016'* [Determination of food waste in household waste in the Netherlands in 2016], CREM Waste Management, Amsterdam.
3. Job van den Berg and Manuel Kaal (January 2017), *'Schattingsstudie naar de mate van verspilling van zuivel en andere drinkbare vloeistoffen in Nederland'* [Estimation survey on the amount of waste of dairy and other potable liquids in the Netherlands], TNS / Kantar Public, Amsterdam.

In this report, we will refer to the above as 1. Self-assessment, 2. Household waste composition analysis (solid), and 3. Liquid Waste Estimation Survey.

Kantar Public was instructed by the Netherlands Nutrition Centre [*'Voedingscentrum'*] to conduct a quantitative study on the level of self-reported waste. This questionnaire provides an opportunity to measure waste awareness indicators and to gain insight into the relationship with alternative disposal routes.

At the request of the Netherlands 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.

¹ Fact sheet on Food Waste by Consumers, Voedingscentrum 2015.

In 2010 and 2013, CREM Waste Management identified in detail the amount and composition of food waste in Dutch households. This study was conducted 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, the goal was to understand why food waste occurs in the first place. To determine the amount and composition of food waste in household waste, physical measurements were performed in residual waste and VFG waste. For this purpose, classification analyses were conducted on these waste streams.

The dairy industry is keen to avoid waste and is looking for ways to do so. An important first step in that direction is to determine how much liquid is wasted in the Netherlands via sinks and toilets. The Liquid Waste Estimation Survey was conducted at the request of the dairy industry (Dutch Dairy Association [NZO], FrieslandCampina and Arla Foods) and Dutch Food Industry Federation [FNLI], and was supervised by 'Milieu Centraal' [Dutch public information service dealing with energy and the environment].

1.2 Research objectives

1.2.1 Self-assessment

The purpose of the Kantar Public study is to gain insight into the level of self-reported waste in the consumers' own households and to identify the waste routes for specific product groups.

In addition, it was investigated if there are differences between amounts of discarded food when broken down for a number of awareness indicators and social demographic characteristics.

Through this study, the researchers arrived at an estimate of the amount of self-reported solid food waste, liquid foods (beverages), and dairy products, and the associated waste routes.

1.2.2 Household waste composition analysis (solid)

The central research question of this study is: what is the amount and composition of food waste through residual waste and VFG waste in Dutch households in 2016?

The associated sub-questions are:

1. What is the volume of food waste 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 and 2013?

1.2.3 Liquid Waste Estimation Survey

The purpose of this survey is to identify liquid waste that is disposed of via sinks and toilets. In other words, how much liquid ends up in the sewer?

Because dairy products are only a part of the drinks that Dutch people consume daily, in the study we also look at the waste from other drinks such as soft drinks, coffee and tea. Through this study, we arrived at an estimate of the amount of waste of dairy and other potable liquids via sinks or toilets.

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).

This concerns the edible parts of food. In addition to avoidable food losses, there are unavoidable food losses in the food chain and in households. These include, for example, peels, stalks, cheese rinds, eggshells, coffee grounds, tea bags and meat and fish remains (bones).

1.4 Study design

The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs have asked the Netherlands Nutrition Centre to coordinate research aimed at providing insight into food waste from consumers.

The Netherlands Nutrition Centre coordinated the self-assessment and composition analysis. The supervisory committee of these studies consisted of:

- Ministry of Infrastructure and the Environment; Bernard Cino
- Ministry of Economic Affairs; Tessa Ooijendijk
- Directorate-General for Public Works and Water Management [*Rijkswaterstaat*]; Olaf Janmaat
- Milieu Centraal; Jonna Snoek and Mariken Stolk
- Netherlands Nutrition Centre; Corné van Dooren and Marjolijn Schrijnen

The studies were performed by Kantar Public and CREM Waste Management.

2. Methods

The research was divided into three steps:

1. Determination of the main routes of food waste through self-assessment (by means of a survey).
2. Determination of solid food waste via household waste: garbage bins / bags and VFG waste (by means of 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
- Toilet
- Outdoor animals (birds, deer, etc.)
- Pets
- Compost heap
- Outdoor rubbish bin
- Other

To ensure comparability with the results for 2010 and 2013, the same methodology has been used wherever possible. The Liquid Waste Estimation Survey is new.

2.1 Self-assessment

The self-assessment was implemented by Kantar Public through an online survey. The sample was drawn from TNS NIPObase and consisted of Dutch people 18 years of age and older, and was representative of age, sex, region, social class and household size. The sample size was 763 respondents. The online survey consisted of 86 questions, was held in the period from 22 to 27 November 2016, and took an average of 15 minutes to complete.

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: almost every day; a few times a week; up to once a week; up to once a month; at most a few times a year; rarely/never. The question posed was identical to that in the CREM consumer survey from 2010. The frequency was multiplied by the volume in kilograms, resulting in an average estimate of the number of kilos of wasted cheese (in this case) 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.

2.2 Household waste composition analysis (solid)

To determine the composition of food waste in household waste, classification analyses were performed in 13 municipalities, of residual waste (13 municipalities) and VFG waste (11 municipalities, because 2 municipalities did not collect vegetable, fruit & garden waste separately), respectively. In each municipality, the residual waste and VFG waste of 10 households was collected separately (in a Big Bag) and sorted.

In the 2 municipalities without individual waste collection methods (mini containers), 25 bags were collected. It is assumed that an average of 2.5 bags per household, per week are collected. For the purpose of comparison, the same neighbourhoods in the same municipalities were used as in 2010 and 2013. In addition, two neighbourhoods were added where residual waste is processed in a post-separation plant. This was done to be in line with the new methodology of Rijkswaterstaat. To minimise the risk of influencing disposal behaviour, the households whose waste was collected for composition were not approached in advance.



The measurements were carried out in November 2016. 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, when composition, a distinction was made between food waste and unavoidable food losses. All food remains were individually weighed, and classified into 7 categories of unavoidable and 16 categories of avoidable food waste.

To obtain the average amount and composition for the Netherlands, the average composition of food losses and waste per municipality (district type) 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 2016 determined by Rijkswaterstaat.

2.3 Liquid Waste Estimation Survey

TNS/Kantar Public assumed a net sample of 1,105 respondents. These were drawn from their own panel and representative of age, gender, education, degree of urbanisation and household size. This sample is of sufficient size to enable reliable estimates of the waste produced.

The respondents installed an app developed for this study. Mobile research using push notifications at specific times (see Figure 2) enabled the researchers to find out about the respondents' experiences when relevant. This gave them a good idea of the waste of dairy and other beverages.

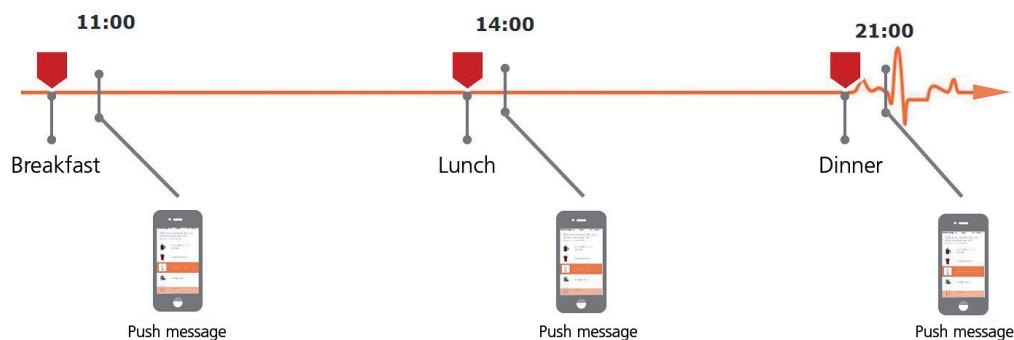


Figure 2: Liquid Waste Estimation Survey via app by means of push notifications at three specific times a day.

To obtain a good spread over weekends and weekdays, and to generate the highest possible response, the sample was organised such that each respondent entered data into the app for two days, spread over weekends and weekdays.

In addition, respondents were asked to measure their waste behaviour three times a day. As a result, the researchers could accurately indicate at what time respondents produced waste, and what type of waste it was.

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, and sauces.

2.4 Purchase of food by households

Purchase data was obtained from market research institute GfK in Dongen on which food products were purchased by households. The data covers week 40 in 2015 to week 39 in 2016. According to the 2013 report, it relates to the volumes per purchasing household and the percentage of purchasing households. The data is required to determine the amount of waste per product group. Because pasta and rice are bought in dried form, the quantities of pasta and rice found in the composition analysis were calculated back into dry amounts (factor 2.5) so they could be compared to the purchase volumes.

3. Results

3.1 Self-assessment

3.1.1 Disposal routes in percentages: household waste, VFG waste, and sinks top of the list

According to the self-assessment, an average of 21.2 kg of food per respondent is wasted per year. Dutch respondents estimated that they waste an average of 11.6 kilograms of solid food and 9.6 litres of liquid foodstuffs (2.6 litres of dairy products and 7.0 litres of other liquid foods).

Food waste disposal routes

	Volume (ml or g)	Garbage bin/bag, residual waste	Organic waste bin, VFG waste	Com- post heap	Sink	Toilet	Outdoor rubbish bin	My pets	Outdoor animals (birds, deer, etc.)	Other
Meat	256	59%	33%	0%	0%	0%	1%	4%	1%	2%
Cheese	143	63%	29%	0%	1%	0%	1%	0%	2%	3%
Yoghurt	1124	38%	3%	0%	43%	13%	0%	0%	0%	2%
Butter	93	81%	10%	0%	1%	1%	2%	0%	0%	6%
Eggs	213	61%	32%	1%	2%	0%	1%	0%	0%	3%
Vegetables and/or fruit	2317	37%	54%	3%	0%	0%	1%	2%	1%	1%
Bread	3813	37%	33%	0%	0%	0%	0%	4%	26%	1%
Leftovers from meals	3156	53%	40%	0%	0%	1%	1%	2%	1%	2%
Sauces	433	67%	8%	0%	11%	5%	1%	0%	0%	8%
Gravy and/or oil	1792	49%	15%	0%	20%	8%	1%	0%	1%	8%
Soup	616	13%	6%	0%	17%	58%	0%	1%	1%	4%
Dairy drink	485	29%	2%	0%	52%	13%	1%	0%	1%	4%
Coffee	1315	15%	12%	1%	68%	2%	0%	0%	0%	2%
Tea	1551	9%	6%	1%	83%	1%	0%	0%	0%	0%
Soft drink	471	4%	0%	0%	88%	6%	0%	0%	0%	2%
Fruit juice	350	6%	0%	0%	84%	7%	0%	0%	0%	2%
Milk and milk substitutes	1027	13%	0%	1%	78%	7%	0%	0%	0%	1%
Wine	332	3%	0%	0%	92%	3%	0%	0%	0%	2%
Beer	94	7%	0%	0%	83%	5%	0%	0%	0%	5%
Potatoes	895	41%	50%	2%	0%	0%	1%	3%	3%	1%
Fish	62	60%	30%	0%	0%	1%	3%	2%	1%	4%
Rice, pasta, couscous	667	45%	45%	1%	0%	1%	1%	4%	3%	1%
Total	21.205	35.0%	25.2%	0.8%	25.1%	4.5%	0.4%	1.5%	5.3%	2.1%

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

The largest waste routes are (Table 2): rubbish bins / bags at 35%, VFG waste at 25%, and sinks at 25%. The route differs greatly per product group. Solid food waste and liquids (drinks) are mainly disposed of via household waste and sinks, respectively. Potatoes, vegetables and fruit end up partly in VFG waste, soup is disposed of partly down the toilet, and part of the wasted bread goes to animals.

3.1.2 Determinants of wastage found (self-assessment)

The number of kilos wasted per respondent depends, among other things, on the level of education, income and household size. The following determinants were found in the self-assessment:

- People with an above-average income waste almost twice as much food as people with a below-average income.
- Households with children waste more food than households without children. Households with children under the age of four waste the most food.
- Respondents who decide what to eat on a daily basis waste more food than respondents who plan what they are going to eat in advance.
- The more often you use a shopping list when shopping, the less food you will waste. The difference amounts from 4 to 13 kg.
- Respondents who were already aware of their food wasting behaviour wasted less food.
- Respondents who consider their ingredients (as carefully as possible) waste less food than respondents who do not.
- Households that often buy too much are households where more food is wasted (15 to 30 kg).

3.1.3 Waste frequency is decreasing (self-assessment)

A frequency table shows how often people said they discarded a certain product in 2010 and 2016. Table 3 gives a summary of two frequencies.

Waste frequency

Solid	Almost every day		Rarely or never		Liquid	Almost every day		Rarely or never	
	2010	2016	2010	2016		2010	2016	2010	2016
Meat	6%	1%	55%	71%	Soup	1%	0%	56%	72%
Cheese	6%	0%	63%	76%	Dairy drink	2%	0%	50%	58%
Yoghurt, custard, quark	5%	0%	45%	60%	Coffee	8%	2%	65%	76%
Butter/margarine	7%	0%	76%	91%	Tea	5%	2%	68%	79%
Eggs	1%	0%	67%	79%	Soft drink	3%	0%	74%	73%
Fruit and vegetables	7%	1%	31%	35%	Fruit juice	2%	0%	66%	68%
Potatoes		0%		60%	Milk and milk substitutes	4%	0%	49%	58%
Rice, pasta and couscous		0%		73%	Wine	1%	0%	57%	61%
Bread	10%	1%	36%	43%	Beer	1%	0%	67%	69%
Leftovers from meals	3%	2%	28%	39%					
Sauces	2%	0%	39%	50%					
Gravy, frying fat or oil	9%	3%	32%	46%					

Table 3: Waste frequency (via self-assessment)

It is interesting to note that the group that rarely or never wastes food has increased for almost all product groups and that waste frequency has declined across the board. This does not apply to drinks: soft drinks, fruit juice, wine and beer. The waste of these product groups remain approximately equal in frequency.

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

3.2 Household waste composition analysis (solid): downward trend

Figure 3 shows how food waste via household waste is divided between avoidable and unavoidable losses. This shows that 53% (32.7 kg) of the food thrown away consists of avoidable food waste, compared with 57% in 2010 and 54% in 2013. The figures in the composition analysis have been adjusted for water absorption by pasta and rice, after which they reached 30.4 kg. The composition analysis shows a declining trend in food waste from 37.4 kilos in 2010 to 34.6 kilos in 2013 and 30.4 kilos in 2016. However, the decline is not significant.

About 13% (4.3 kg) of the food we waste in the Netherlands is prepared food (e.g., cooked or fried products). About 17% (5.4 kg) of the food is still untouched inside its packaging, or peel.

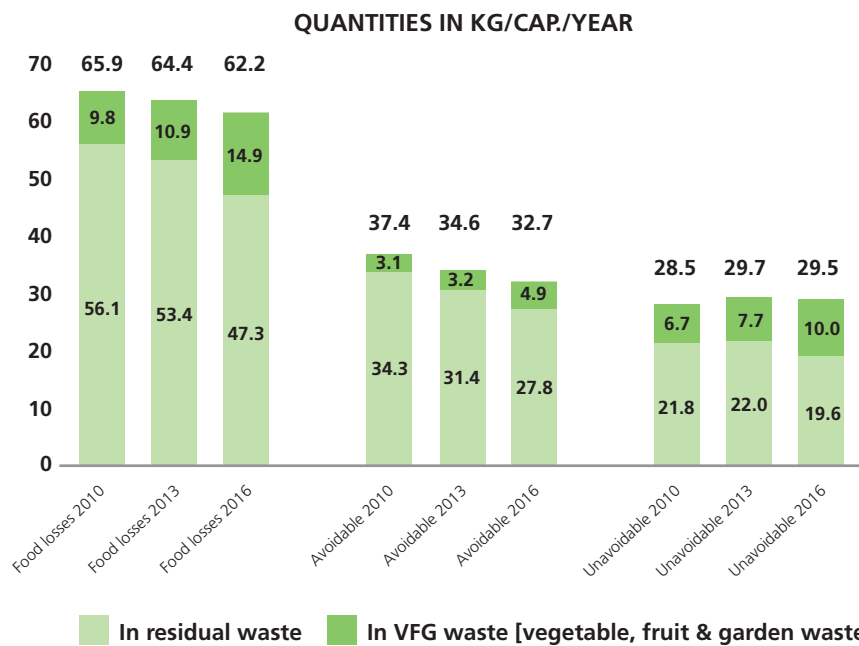


Figure 3: Distribution of food waste via household waste across avoidable and unavoidable (2010, 2013 and 2016)

The amounts per product group are broken down in Table 4. Food waste composition is largely similar to 2013:

- 29% consists of vegetables (16%) and fruit (14%); apples, oranges, carrots, bananas and cucumbers make up an important part of this.
- Bread, pastry and cake together account for 23%; bread has a share of 20%; for the most part, this consists of half loaves and loose slices and rolls; pastry and cakes were separately sorted and make up about 4% of total waste.
- Cheese (2%) and dairy products (7%) together account for 9%; cheese is only a small part of this; the majority consists of thick liquid dairy products; a significant part of this type of products goes down the sink; this is only the part that was disposed of via household waste.
- Rice and pasta together make up a share of 12% and are almost invariably cooked; a lot of rice is in takeaway containers; this is comparable to 2013 (though there was more pasta and less rice in 2016).
- 7% of food waste consists of potatoes; we noticed that relatively many potatoes (29%) are disposed of via VFG waste, especially raw potatoes; potatoes in residual waste are mainly found in stews and as mashed or boiled potatoes.
- Meat and fish together have a share of 9% and are largely discarded via the residual waste; fish takes up a small proportion (0.5%); meat waste consists mostly of beef and pork and to a lesser degree of chicken.
- More than 3% consists of sauces and fats in the residual waste. In 2013, this was 7.5%.

3.3 Integration of results of the self-assessment and composition analysis (solid)

To arrive at a good estimate of the waste routes outside of household waste, for the solid products (including sauces, fats and dairy products) we have integrated the results of the self-assessment (in percentages) with the results of the composition analysis (Table 4). By applying the ratio in percentages of other routes to the kilos from the composition analysis, we have made an estimate of waste via other routes. The solid food waste (including sauces, fats and dairy) via other routes is thus estimated at 10.8 kilos per person per year, which brings the total waste to 41.2 kilos per person per year.

Waste per solid food product group (including sauces, fats and dairy products)

Product groups	Composition analysis (solid)				Self-assessment		Other routes	Total	
	Residual waste	VFG waste	Total (kg/year)	Percentage	Residual waste + VFG waste	Other routes	Weight composition analysis × % self-assessment	Weight (kg/year)	Percentage
Meat	2.45	0.19	2.64	8.7%	92%	8%	0.24	2.88	7.0%
Fish	0.12	0.03	0.15	0.5%	89%	11%	0.02	0.18	0.4%
Cheese	0.66	0.03	0.69	2.3%	92%	8%	0.06	0.75	1.8%
Dairy products*	2.17	0.03	2.20	7.2%	32%	68%	4.59	6.81	16.5%
Eggs	0.18	0.02	0.20	0.7%	92%	8%	0.02	0.22	0.5%
Vegetables	4.07	1.12	5.19	17.1%	91%	9%	0.48	5.67	13.8%
Fruit	3.08	1.33	4.41	14.5%	91%	9%	0.41	4.82	11.7%
Potatoes	1.59	0.65	2.24	7.4%	91%	9%	0.21	2.45	6.0%
Bread	5.59	0.79	6.38	21.0%	70%	30%	2.77	9.15	22.2%
Pastry and cake**	1.15	0.02	1.17	3.9%	70%	30%	0.51	1.68	4.1%
Leftovers from meals	0.09	0.08	0.17	0.6%	92%	8%	0.01	0.18	0.4%
Rice****	0.68	0.08	0.76	2.5%	90%	10%	0.09	0.85	2.1%
Pasta****	0.72	0.07	0.79	2.6%	90%	10%	0.09	0.88	2.1%
Sweets and snacks	0.68	0.01	0.69	2.3%	100%	0%	0.00	0.69	1.7%
Sandwich toppings	0.20	0.00	0.20	0.7%	100%	0%	0.00	0.20	0.5%
Sauces and fats***	1.04	0.01	1.05	3.5%	66%	34%	0.55	1.60	3.9%
Soups	0.18	0.00	0.18	0.6%	19%	81%	0.75	0.93	2.3%
Other	1.04	0.20	1.24	4.1%	100%	0%	0.00	1.24	3.1%
Total	25.69	4.66	30.35	100%			10.80	41.18	100%

Table 4: 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 percentages based on 3/4 of thick dairy products and 1/4 of liquid dairy products

** Percentages for bread-based pastry and cake. In practice, these will probably be lower than bread.

*** Weighted average of sauces and fats (gravy, etc.).

**** Rice and pasta adjusted for water absorption (by a factor of 2.5).

The conclusion is that bread accounts for the greatest share in solid food waste, followed by dairy products, vegetables, fruit and meat.

3.4 Share of waste in relation to the quantities purchased

To determine which part of the purchased solid food ends up in household waste unconsumed, complete and reliable purchase figures are required. Food waste monitoring in 2010 made use of estimates from a variety of sources, of which Statistics Netherlands (CBS) was the most important. In 2013 and 2016, figures from market research firm GfK were used. GfK performs regular household surveys. These figures make it possible to determine the average number of kilograms of food purchased by consumers per capita per year for each main category.

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 must be adjusted to allow them to be used with the purchase figures.

Coffee grounds and tea bags (8.9 kg) have been left out of the unavoidable losses because they are related to liquid waste. Thus, 20.6 kilograms of unavoidable solid food loss remains.

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. Only pasta and rice have been adjusted for this, because they increase significantly in weight (by a factor of approx. 2.5) due to water absorption when cooking. Rice is the only product group whose purchase figure is not derived from the GfK figures, but from the consumption figures of the *Voedsel Consumptiepeiling* (VCP) [National Food Consumption Survey] of 2007–2010. The consumption figure for rice is 5.51 kilos per person, per year, and the figure for pasta is 8.31 kilos (both slightly 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 classification analyses: a lot of the rice found was prepared takeaway rice in takeaway containers.

Share of food waste

	2010	2013	2016
Total purchased	376	368	337
Unavoidable loss	22	19	21
Total edible	353	349	316
Waste composition analysis*	35	32	30
Waste via other routes*	13	15	10
Total waste*	48	47	41
Percentage of waste with respect to edible	13.6%	13.5%	13%
Consumption	306	301	276

Table 5: Share of food waste (solid, edible) in kilograms relative to quantities purchased (2010, 2013 and 2016).

* Amounts adjusted for liquid absorption by rice and pasta.

Table 5 gives an overview of kilos and weight percentages of the share of food waste, divided into unavoidable and avoidable 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 30.4 kg/cap./year, and the above-mentioned calculated percentages of waste via other routes amount to 10.8 kg/cap./year. In total, Dutch consumers waste 13% of all solid food.

Of the 337 kilos per capita per year of solid food bought by households (GfK, 2016), 61.4 kilograms end up not being consumed. 20.6 kg of this is unavoidable, 41.2 kg avoidable waste (30.4 kilos via household waste plus 10.8 kilos via alternative routes). Indoor household consumption is therefore 337 – 60 = 276 kilos.

Of the solid, edible food (316 kilos) 13% (41.2 kilos) is wasted. This is less than wasted in previous periods, but the difference is not significant (48 kilos in 2010, compared with 47 kilos in 2013). Because consumption has also dropped, the percentage of waste has fallen less than the volume of waste in kilos (from 13.6% in 2013 to 13%).

Percentage of waste per product group

Product group	Kg waste per person	Bought per purchasing household	Percentage wasted per person*
Meat and meat products	2.88	65.30	10.2%
Fish	0.18	7.40	7.1%
Cheese	0.75	19.49	8.5%
Dairy products (excluding cheese and butter)	6.81	180.17	8.3%
Eggs	0.22	10.79	4.9%
Vegetables	5.67	89.53	18.9%
Fruit	4.82	87.11	16.5%
Potatoes	2.45	47.41	14.3%
Bread (excluding pastry and cake)	9.15	66.43	30.4%
Rice (dry)***	0.85	5.51	33.5%
Pasta (dry)***	0.88	8.31	23.2%
Sweets and snacks (excluding pastry and cake)	0.69	33.03	4.6%
Sauces and fats (incl. butter)	1.60	32.81	10.7%
Pastry and cake	1.68	21.65	17.1%
Soup**	0.93	7.18	28.6%
Other categories	1.24	44.82	6.1%

Table 6: Percentage of waste per product group relative to the amount bought per purchasing household (based on an average household of 2.2 persons).

* 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 there is insufficient data to adjust it.

*** Pasta and rice are adjusted for water by a factor of 2.5. These are not purchase data, but consumption data from the 'Voedselconsumptie Peiling' [National Food Consumption Survey] conducted in 2007–2010.

The share of waste varies per product group, relative to the edible part of the purchased goods (Table 6). For example, the share is high for rice (34%), pasta (23%) and bread (30%). For cheese, fish, eggs, dairy products and sweets the share of waste is below 10%. Vegetables, fruits and potatoes form a middle group at 14 to 19%.

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

On average, 157 millilitres per day are wasted per respondent (see Figure 4). Coffee and tea account for the largest part of this (84 ml per respondent, per day). Converted to waste per year, based on this study, we estimate this at 57.3 litres, of which 30.7 litres of coffee and tea. Dairy products follow with 10.2 litres of milk, 2.6 litres of dairy drinks and 4.0 litres of thick dairy (yoghurt, custard, quark, etc.). Soft drinks and juices are estimated at 6.6 litres a year and sauces at 2.6 litres. The total amounts of waste from beverages and thick liquids (dairy products and sauces) are 50.7 litres and 6.6 litres respectively. In relation to the purchased quantities per purchasing household, this is 20.5% of dairy products and 5.5% of soft drinks and juices.

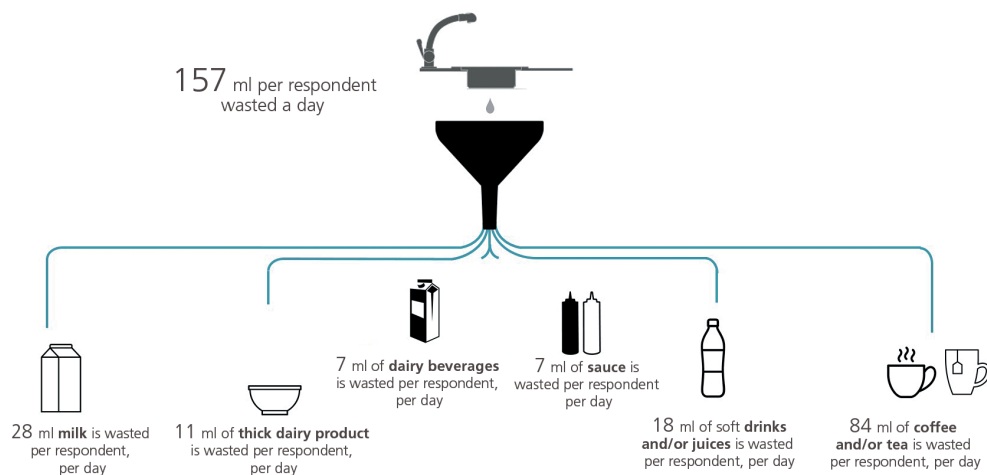


Figure 4: Results of the Liquid Waste Estimation Survey in millilitre per respondent, per day.

Given the quantities, coffee and/or tea are often made in larger amounts with a relatively high occurrence of leftovers. As soon as coffee or tea has cooled down, many people throw it away. Coffee and tea are products based on boiled water, which is usually from the tap, which seems to suggest that people find it easier to throw it away.

We noticed that most of the milk people throw away is in the form of leftovers from glasses/ mugs. This was also reflected in the reasons people gave as to why they throw something away. Four out of ten respondents indicated that they no longer needed the product or couldn't finish it.

We noted that there is great variation in waste per day, which can be explained by the fact that people apparently throw more food away on weekends than during the week. The amount of wastage varies greatly throughout the day. It occurs after specific 'events', such as shopping.

In general, there is no correlation between the amount of liquid that is kept in the fridge of each category, and the amount of waste. The exception to this is thick dairy product waste. For this category, waste volumes are higher in full refrigerators than in empty refrigerators.

4. Discussion

4.1 Self-assessment results in underestimation

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. They 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. By their own estimation, this is an average of 11.6 kg of solid food and 9.6 litres of liquid food. This is a good three times lower than the figures that emerged from the composition analysis. The group that entered 'never' largely determined the low average, but the composition analysis revealed that every household throws things away. Self-assessment therefore continues to result in underestimation.

4.2 Results per person or per household?

The self-assessment revealed a link between the amount of food that is thrown away and the size of the household. The bigger the household, the more food is wasted. There is also a minor link between the amount of wasted liquid and the size of the household (estimation survey). The bigger the household, the more liquids are wasted. The amount of waste in single-person households can be seen as an indicator of waste at the level of the individual.

The waste volumes per respondent have been reported in the Self-assessment and the Liquid Waste Estimation Survey. However, when interpreting the results, it should be noted that the report describes the degree of waste when the respondents were at home. That is, waste outside the home is not included in this report. 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 other household members. It is not possible, therefore, to identify the waste produced by one specific person. The reported volumes apply to specific individuals, but it is likely that the reported waste is the result of the behaviour of multiple persons.

This is why we did not work with absolute figures from the survey, but only with percentages, thereby circumventing the problem.

4.3 Studies on beverage waste paint a varied picture

Not much is known about beverage waste. According to an earlier estimate by Blonk Consultants from 2010, 3 to 12 kg of drinks disappear down the drain, excluding coffee and tea, but this seems like an underestimate. According to the Liquid Waste Estimation Survey, this figure is 25.9 litres (kg), more than double that figure. The total volume of beverage waste estimated via the app is 8 times as high as the corresponding volume in the self-assessment. Thick liquids were also included in the composition analysis and appear to be in the same order (5.9 kilos versus 6.6 litres). These are actually measured in a twofold manner. Because a new measurement method was used, with more types of beverages, the results cannot be compared with earlier research. The 16.8 litres of dairy products in the estimation survey is higher than the estimate of dairy products that was made in the CREM study of 2013. The 2013 estimate was made based on the dairy purchase figures combined with the overall percentage of solid food waste (13.5%).

4.4 Decrease in purchase volume may be a cause of less waste

A comparison of the purchase volumes for 2016 (week 40 of 2015 to week 39 of 2016) with those for 2013 (the period up to week 20 of 2013) reveals that the volumes for each purchasing household have decreased for all categories. Compared with 3.5 years ago, buying households are buying less volume (per buying household) for home use. Reasons for this may include:

- Increase in the number of smaller households
- More older households (ageing population)
- Increase in home delivery services for meals
- Increased share of smaller packages (less volume)
- More health-conscious consumption (consuming less soft drinks and juices, meat, etc.)
- More consumption outside the home

It cannot be ruled out that in 2013 not all weeks of the year were included (holidays, seasonal influences), which would explain part of the difference.

4.5 Establishing reliability

In the composition analysis, confidence margins were used to examine whether there is a significant difference (Table 7). The differences in proportions of avoidable and unavoidable food waste in residual waste and VFG waste between the years 2010–2013 and 2013–2016 do not differ significantly, nor do they do so over a longer measurement period from 2010 to 2016, except for unavoidable food remains in VFG waste (8.5% in 2010 and 12.4% in 2016). One of the causes of the high confidence margin is that the variation in the amount of food waste between households is very high.

Confidence margins in the composition analysis

year	percentages			kilos			kilos, including estimation of routes		
	2010	2013	2016	2010	2013	2016	2010	2013	2016
minimum	16.1%	15.7%	17.0%	32.7	29.5	26.2	41.9	40.0	35.5
average	18.8%	18.8%	20.0%	37.4	34.6	30.4	48.0	47.0	41.2
maximum	21.5%	21.9%	23.0%	42.1	39.7	34.6	54.1	54.0	46.7

Table 7: Confidence margins in the composition analysis.

In estimation studies, Kantar always assumes a confidence interval, rather than significance levels. To this end, they looked at the overall variance of the given responses. On this basis, they chose the median of the first half (Q1) and the median of the second half (Q3). The difference between them is the confidence interval. If the dispersion is very large, these numbers will also be very far apart. This is in fact the case in this study. This is directly related to the difference in frequency indicated by the respondents.

Part of the decrease compared with previous studies is due to the estimation of other routes by consumers. This was 10.6 kilos in 2010, 12.4 kilograms in 2013, and 10.8 kilos in 2016. This uncertain estimate is thus responsible for part of the decrease compared to 2013.

4.6 Relationship with the ‘*Monitor Voedselverliezen*’ [Food Waste Monitor] (WUR)

Since 2009, Wageningen UR Food & Biobased Research has been monitoring food waste in the ‘*Monitor Voedselverliezen*’. WUR also monitored food waste in 2014. All residual waste streams are taken into account and all manner of sources consulted to ascertain which of these derive from the food chain.

According to the Food Waste Monitor, in 2015 food waste was between 1.77 and 2.55 million tonnes for the whole of the Netherlands. Converted per capita (based on 16,900,726 inhabitants in 2015), this is between 105 and 152 kilos per person. The general picture that emerges from the Food Waste Monitor is that not much changed in the total amount of food wasted between the years 2009 and 2015. The Monitor is concerned with waste over the entire chain at the macro level (albeit recalculated to residents). The present study is only about waste in households, and is furthermore measured differently. If we estimate solid food waste in households (excluding beverages) at around 41.2 kilograms, this means that households are responsible for a share of 27% to 39% of the total waste in the chain.

The European FUSIONS project (2015) reports that at EU level, 53% of food losses take place with consumers and that about 60% of these losses (32%) consist of avoidable waste, which corresponds to the range of 27% to 39%.

4.7 Suggestions for further research

The monitoring committee recommends repeating this study in a number of years to see if the current, apparently downward trend will continue.

We recommend working with larger samples, which will more readily reveal any significant differences.

It may be a good idea to expand the survey with the app on beverage waste to include other solid food product groups. Respondents would then need to keep track of a limited number of products, rather than all product groups at once.

The household waste composition analysis has so far been the best method for measuring solid food waste, but not for thick liquid foods. We recommend using the app to survey milk, thick dairy products and sauces. This would also avoid double counting.

Colophon

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