Food Waste statistics for Iceland in 2019

Final methodological report

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1. Introduction

This report discusses a research project on the quantity of food waste within the whole food chain in Iceland in 2019. The project was situated at the Environment Agency of Iceland, but partially funded by Eurostat, under the call number B27622018-WASTE for data collection on food waste, statistics, exports and imports of waste, project no. 831322 — 2018-IS-FoodWaste. The preparation of the project started in May 2019, data was collected in September to November 2019, and was finalised with this report in January 2020. The research is the second to date on the quantity of food waste in Iceland. The first one was conducted in 2016, also situated at the Environment Agency and founded by Eurostat. A temporary employee, Sociologist Margrét Einarsdóttir, was recruited to implement the research and analyse the data, with Birgitta Stefánsdóttir, Advisor at the agency, acting as project manager.

Self-administrated, on-line surveys were used to collect the data. The results indicate that Icelandic households waste substantial amounts of food, each individual wasting up to 20 kg of edible and 25 kg of inedible food annually and pouring 5 kg of cooking oil or fat and 40 kg of liquid down the drain. This amounts to 90 kg of food and drink per person per year. In other words, Icelandic homes annually waste in total 7,152 tonnes of edible food, 9,123 tonnes of inedible food, 1,840 tonnes of cooking oil and fat, and 14,670 tonnes of drinks and other liquid food, for a total annual waste of 32,785 tonnes. The figures are identical to the 92 kg of food and drink per person per year that Stenmarck, Jensen, Quested, and Moates (2016) estimated for the EU-28, and in line with the results of Koivupuro et al. (2012) from Finland. Also, the difference in household waste of edible food in Iceland in 2016 and 2019 is not statistically significant. On the other hand, the 2016 research showed considerably higher figures regarding inedible food, liquid, and oil. Notably, however, research on food waste is still at an early stage and caution should be taken when comparing results.

The results on the food waste of Icelandic companies are somewhat limited due to a lack of data. Therefore, figures on waste within agriculture, fishing, fish processing, manufacture of oil and fat, manufacture of dairy products, and manufacture of beverages are lacking. The available figures amount to annual food waste of 40,845.5 tonnes, or 112.6 kg per person per year. The figures are slightly higher than the estimate of Stenmarck et al. (2016) for the EU-28 of 81 kg per person per year, and where the whole food chain (except for households) is reached. It should be emphasised again that research on food waste is still at an early stage and caution should be taken when comparing results.

This report starts with an account of the objectives of the research, followed by a short discussion on the Icelandic context of the research, and definitions of relevant concepts. Then the methods of the household research and the presentation of it results are discussed, as well as the methods and results of the company research. The report ends with an annex on metadata.

2. Ágrip

(Abstract in Icelandic)

Markmið rannsóknarinnar sem hér er kynnt var að mæla umfang matarsóunar á Íslandi árið 2019 á öllum stigum virðiskeðjunnar, þ.e. hjá fyrirtækjum í ræktun og framleiðslu, sölu og framreiðslu matar sem og hjá heimilum landsins. Rannsóknin beindist að því hve miklu er hent að nýtanlegum mat og ónýtanlegum matarafgöngum, þar með talið hversu miklu af drykkjum og matarolíu er hellt niður. Sambærileg rannsókn var framkvæmd af Umhverfisstofnun árið 2016. Aðferðafræði rannsóknanna tveggja var sambærileg, og báðar hlutu styrk frá Hagstofu Evrópusambandsins, Eurostat, með það að markmiði að niðurstöður nýttust sem hagtölur um umfang matarsóunar hérlendis.

Rannsóknin var úrtaksrannsókn og skiptist í tvo hluta, heimilishluta og fyrirtækjahluta. Í heimilishlutanum var tekið tilviljunarkennt úrtak 1.067 heimila úr Þjóðskrá og þátttakendur beðnir um að vigta þann mat sem fór til spillis á heimilinu í eina viku og skrá niðurstöður í þar til gerða skráningargátt. Skráningar bárust frá 90 heimilum og svarhlutfall því tæp 9%. Í fyrirtækjahlutanum var tekið tilviljunarkennt úrtak úr fyrirtækjaskrá Hagstofunnar. Samtal lentu 762 fyrirtæki í úrtaki, lagskipt eftir atvinnugreinaflokkum. Svör bárust frá 80 fyrirtækjum, eða tæplega 11%. Svörun var hins vegar misgóð eftir atvinnugreinaflokkum og fór það svo að engin eða ófullnægjandi gögn bárust frá landbúnaði, útgerð og fiskvinnslu, framleiðslu á olíu og fitu og mjólkurframleiðslu. Nauðsynlegt er að hafa í huga þegar niðurstöðurnar eru skoðaðar að lágt svarhlutfall dregur úr áreiðanleika þeirra.

Niðurstöðurnar benda til að íslensk heimili sói umtalsverðum mat. Þannig má áætla að íslensk heimili hendi um 20 kg af nýtanlegum mat, 25 kg af ónýtanlegum matarafgöngum, 5 kg af matarolíu og fitu og 40 lítrum af drykkjum á mann á ári, eða samtal ríflega 90 kg. Með öðrum orðum, þá bendir rannsóknin til að íslensk heimili hendi samtals 7.152 tonnum af nýtanlegum mat á ári, 9.130 tonnum af ónýtanlegum matarafgöngum, 1.840 tonnum af matarolíu og fitu og 14.670 tonnum af drykkjum sem samantekið gerir 32.785 tonn. Ekki mælist tölfræðilega marktækum munur á þeim nýtanlega mat sem fór til spillis á íslenskum heimilum nú og árið 2016 (23 kg á mann á ári) en marktækt minna var hent af ónýtanlegum matarafgöngum nú en þá (39,2 kg). Þegar kemur að matarolíu/fitu og drykkjum er samanburður milli áranna hins vegar óáreiðanlegur sökum þess að árið 2016 náðist ekki að villuprófa gögnin. Það var hins vegar gert við gögnin nú og leiddi sú prófun í ljós verulegar mælingaskekkjur sem hægt var að leiðrétta.

Út frá niðurstöðum fyrirtækjarannsóknarinnar má síðan áætla að neysluhluti virðiskeðjunnar - þ.e. heild- og smásala og veitingasala og framreiðsla matar í skólum og á heilbrigðisstofnunum – sói ríflega 22 kg af nýtanlegum mat á hvern íbúa árlega, 3,6 kg af ónýtanlegum matarafgöngum, 1,6 kg af olíu og fitu og 14,6 lítrum af drykkjum, samtals 42,2 kg. Á landsvísu má áætla að þetta geri samtals 8.110 tonn af nýtanlegum mat, 1.320 tonn af ónýtanlegum mat, 5.310 tonn af drykkjum og 570 tonn af matarolíu og fitu. Vegna skorts á gögnum veitir rannsóknin hins vegar ekki innsýn inn í hversu mikið af hráefni til

matargerðar og tilbúnum mat fer til spillis innan frumframleiðslugreina og matvælaframleiðslugreina á Íslandi.

Niðurstöður rannsóknarinnar benda til að matarsóun íslenskra heimila sé sambærileg því sem gerist í öðrum löndum Evrópu. Þannig hefur verið áætlað að innan Evrópusambandsins sói heimili milli 83 og 101 kg af mat á ári þegar allt er talið, nýtanlegum matur, ónýtanlegir matarafgangar, olía og drykkir. Niðurstöðurnar fyrir heild- og smásölu eru hins vegar heldur lægri (6,7 kg á mann á ári) en evrópskar áætlanir (9 kg á mann á ári) en heldur hærri fyrir veitingasölu (31 kg á móti 21 kg) (Stenmarck, Jensen, Quested, and Moates, 2016).

Matarsóun er málefni sem sífellt fær meiri athygli, ekki einungis hér á landi heldur um öll Vesturlönd. Því hefur verið haldið fram að allt að þriðjungi þeirra matvæla sem framleidd eru í heiminum sé sóað og því er til mikils að vinna að taka á þessu vandamáli. Með því að draga úr matarsóun má nýta betur auðlindir og spara fé, auk þess sem fullyrða má að sóun matar leggi umtalsvert til losunar gróðurhúsalofttegunda. Loftslagsbreytingar eru áskorun sem gervöll heimsbyggðin tekst nú á við.

Á síðustu árum hefur verið gert átak í að mæla umfang matarsóunar, einkum í Evrópu, en það hafa ekki reynst auðveldar mælingar í framkvæmd og enn liggur ekki fyrir stöðluð aðferð við slíkar rannsóknir. Taka verður allan samanburð milli rannsókn með þeim fyrirvara. Eitt markmiða þessarar rannsóknarskýrslu er að koma með tillögur að stöðluðum aðferðum við rannsóknir á umfangi matarsóunar á Íslandi. Tillögurnar eru kynnar í sérstökum viðauka.

3. The Objectives

The main objective of the research project was to obtain detailed and reliable statistics of the sources, types, and management of food waste in Iceland for the year 2019, regarding both the food supply and the consumption chain. The design of this study is based on the design of the 2016 Food Waste Research Project. Both studies were funded by Eurostat. The second objective of the current research was to develop standardised methods to measure food waste in Iceland. The outcomes of that development are reported in a separated report.

In accordance with the objective of collecting information on food waste from the whole food usage hierarchy, the research was multipartite. Firstly, the focus was on both households and companies; secondly, regarding the companies, the focus was on 1) the production of food; 2) the trading of food; and, 3) the serving of food. A separate survey was designed for each category, and the participants were asked to weigh and file the amounts of food waste they disposed of over a period of one week into the relevant on-line web portal, as was the case in the 2016 Food Waste Research.

4. The Icelandic Context

Iceland is a geographically isolated island country. It has the smallest population of the Nordic countries, or 356,991 inhabitants at the beginning of 2019 (Statistics Iceland, n.d.-a). Nevertheless, the area of the country is considerable, at 103,125 km². Hence, the country is sparsely populated, with 3.2 inhabitants per km². The majority of the population, or 229,490 (64.0 %), lives in the capital area,[1] with the rest, or 129,290 (36.0 %) in the countryside. The population of the largest town outside the capital area, Akureyri, is 18,950. The main industries of the country are fishing, heavy metal processing, and tourism.

[1] The capital area includes the municipalities of: Reykjavík (the capital); Kópavogur; Seltjarnarnes; Garðabær; Hafnarfjörður; and Mosfellsbær.

5. Definition of Concepts

There has been a lack of consistency for the definition of food waste in statistics and research. Therefore, a clear definition of the concept of food waste is needed for each case of food waste research (Östergren et al., 2014).

The definition applied in this research is identical to the one used in the 2016 Icelandic Food Waste Research, and relies on Östergren et al. (2014) definition of food:

- 'Food means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be eaten by humans.' (p. 20).

As in the 2016 research, food is further divided into edible food and inedible food as follows:

- Edible food 'has or had the potential to be eaten by humans'. The definition 'recognizes food which is no longer considered edible (since e.g. it's molded, rotten or the date has expired), but which has had the potential to be eaten, … even though it's not edible at the point of disposal' (p.22).
- Inedible food is the part of food that is not recognised as fit for human consumption, such as bones, eggshells, peels, coffee grounds, etc.

What is considered edible and what is considered inedible may vary between persons, as well as between cultures. As the research depends on self-administrated surveys, it should be noted that the results of the research are subjective rather than objective, including the results on the distinction between edible and inedible food.

Participants were asked to report all food waste regardless of how the waste was treated. Therefore, food waste fed to animals is included in the research, unlike in the EU-28 estimate of food waste level where such waste is excluded, at least in the household studies (Stenmarck et al., 2016). As in the EU-28 estimate, data on food waste disposed of via the sewer was measured separately, but unlike the EU-28 estimate, cooking oil and fat were also measured separately.

6. Methods of Household Research

6.1. Sample design

The sample design of the household research was one one-stage simple random sample without stratification. The sample units are families, as defined by the Icelandic Population Register, selected from that register. The lowest age limit of the sample was 18 years, with no upper age limit.

The gross sample size was 1,067 families, set to meet the demand for a confidence level of 99%, with a confidence interval of ±4%, from a population of 205,173 families. This was the number of families in Iceland in March 2019, according to Statistics Iceland.

The sample was collected by Gallup Iceland.

6.2. Weighting and substitutions

The data was not weighted, adjusted to external data, nor were any substitutions applied. The data was also not adjusted for nonresponse. Although often applied in statistics, nonresponse adjustments have been criticised for assuming 'that those responding from a particular subgroup are about the same as those not responding on the variables the survey is trying to estimate', and it is argued that this assumption is 'almost always untestable' (Fowler, 2014, p. 136). Considering the limited existing results on household food waste, a nonresponse adjustment was not assumed to increase the quality of the data.

6.3. Sampling errors: standard errors, and effective sample size

There were 1,067 households in the sample. In total, 15 of the households proved to be non-eligible (staying in institutions or having already emigrated), giving a net sample of 1,052 households.

The mean, the total member of observations, and the standard errors for the food waste variables are shown in chapter 7 Results of Household Research.

6.4. Non sampling errors

Errors other than sampling errors can be divided into three categories: coverage errors; nonresponse errors; and, measurement errors.

6.4.1. Sampling frame and coverage errors

The sampling frame is the Icelandic national register. All family numbers in the register of those aged 18 and older and living in Iceland, according to the register, were eligible for the sample. Those registered at institutions were excluded from the sample.

The national register is continuously updated. However, it does not always contain updated information on those who changed their residence. People may move abroad or to an institution without providing this information to the national register. Therefore, the national register may overrepresent young people who tend to go abroad for their studies and older people who sometimes maintain a private address despite living in an institution. This possible coverage error was considered negligible and was not adjusted for.

6.4.2. Nonresponse errors

The average age of the respondents (50.7 years old) was significantly higher than the average age of the non-respondents (43.1 years old), t(1050) = -3.84, p =. 00, and those with a higher income (monthly income ISK 701,000 or more) were more likely to respond than those with a lower income (monthly income ISK 700,000 or less), $\chi^2(1, N=202) = 5.78$, p = .02. Significant differences did not appear regarding gender, $\chi^2(1, N = 1052) = .25$, p = .61, residence (urban vs. rural), $\chi^2(1, N = 1052) = .19$, p = .66, or number of household members, $\chi^2(5, N = 290) = 1,17$, p = .53.

The bias was not countered for.

6.4.2.1. Achieved sample size and unit nonresponse

In total, the achieved sample size was 90 households. As Table 1 shows, the nonresponses occurred in two stages. The first stage occurred when consent for participation in the kitchen diaries was sought. In total 289 of the sampled families, or 27.5%, agreed to participate at this stage. The second stage of the non-response occurred during the filing of the kitchen diaries. In total, 201 families who had consented to participate failed to file the diaries, giving a final response rate of 8.4%. In other words, the unit nonresponse was 91.6%.

Table 1. Status of sampled families in the research, and in the kitchen diaries

Status in sample	N (%)	Status in kitchen diaries	N (%)
Agreed to participate	289 (27.5)	Participated	90 (8.6%)
		Did not participate	199 (18.9%)
Declined to participate	255 (24.3)		
No telephone number	273 (25.9)		
At sea/temporarily abroad	11 (1.0)		
Not reachable by phone	222 (21.1)		
Not enough Icelandic language ability	2 (0.2)		
Total	1052 (100.0)		

6.4.2.2. Item nonresponse

It was assumed that participants in the kitchen diaries who did not report on some of the food waste types did indeed not waste any such types of food. These missing values were therefore converted into zero values.

No imputations were applied.

6.5. Mode of data collection

6.5.1. Self-administrated, online kitchen diaries

The mode of data collection used in the household research was self-administered, online kitchen diaries. The duration of registration was one week. The online diaries were originally designed for the 2016 Icelandic Food Waste Research, where the duration of registration was also one week.

As digital technology has improved, the advances of online research have been recognised and such research has become even more popular (Fowler, 2014; Fricker & Schonlau, 2002; Horevoorts, Vissers, Mols, Thong, & van de Poll-Franse, 2015). Internet access is widespread in Iceland, and figures show that in 2014 some 97% of Icelanders used the internet regularly (the highest percentage of regular internet use in Europe) (https://hagstofa.is/media/43822/hag_150123.pdf, p. 1). On that grounds, it was decided to offer an online kitchen diary format in the 2016 Icelandic research. The experience of the online diary in that research was positive, therefore it was decided to use the same mode of data collection in the current research, with the 2016 diary portal updated to the newest digital mode. The online portal was designed by the IT department at the Environment Agency of Iceland and supports both personal computers and smartphones. The final form of the on-line kitchen diary is presented in Figure 1.

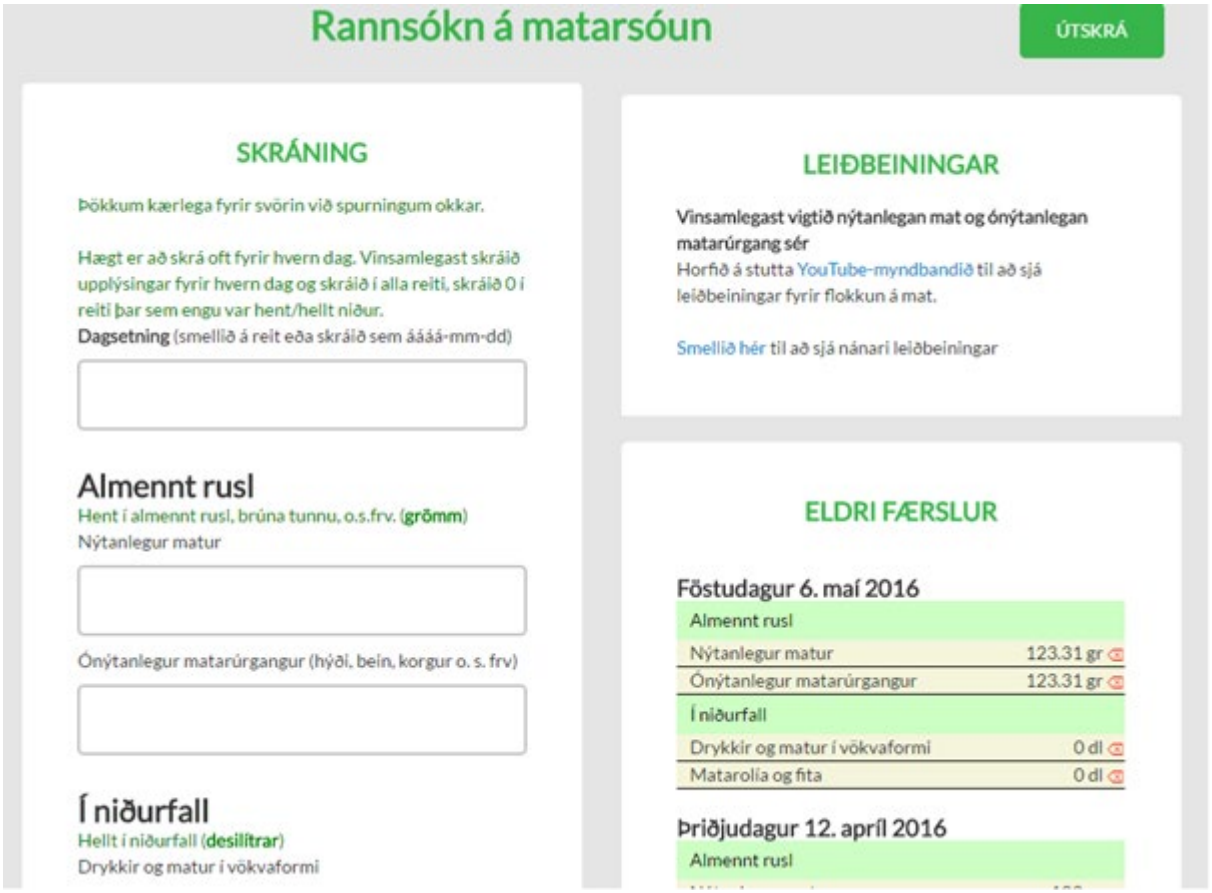

Figure 1. Online kitchen diary form for households

To overcome the known disadvantages of online data collection (Fricker & Schonlau, 2002, p. 359), a mixed response mode of internet and mail was applied. In total, 6 responses, or 6.7%, were received by mail, and 84, or 93.3%, were received online. On the other hand, the contact strategy was limited to access by phone.

6.5.2.Mode of collection of participation consent

A consent to participate was collected by phone. The consents were collected by Gallup Iceland.

Every person in the sample contacted by phone was asked to answer three background questions on 1) the number of household members; 2) the number of children in the household; and, 3) the total income of the household. In total 290 households, or 27.2%, answered the former two questions, but only 202, or 19.2%, answered the question on their household income. Background information on age, gender, and residence was collected through the National Register of Iceland.

Every respondent was then asked if s/he consented to participate in the kitchen diary logging. Those who agreed received a username and password to the kitchen diary web portal. Those who did not have access to a computer/internet connection were offered a kitchen diary form via paper by post. The web portal allowed for an on-line check of the registrations. Those who had not registered on time were reminded of their participation by email, text messages, and phone. In the start phase of the research project, the Environment Agency of Iceland also emphasised good media coverage to facilitate participation.

6.5.3.Measurement and processing errors

Measurement and processing errors can be classified into three categories: design errors; interviewer errors; and, processing errors.

6.5.3.1. Design errors

An immediate problem in the design of food waste research is that the collection of the data is quite time-consuming (Jörissen et al., 2015). When designing the kitchen diaries for the 2016 Icelandic Food Waste Research, an effort was made to simplify them in order to reduce the amount of time needed to complete them. Nevertheless, the demands of time and effort required to register could have led to nonresponses, and further improvement of the design is needed.

The kitchen diaries were self-administrated, and a researcher was not present to control the quality of the measurements. The measurements are therefore subjective rather than objective. The method required minimal calculating and writing skills in mathematics. Thus, those without such skills might be undercovered in the research (Fowler, 2014). At the present, 13.4% of the Icelandic population has foreign citizenship (Statistics Iceland, n.d.-a). In order to facilitate the participation of that segment of the population, the online diaries were translated into English and Polish.

Internet surveys have been criticised for not reaching those who do not have access to an internet connection (Brick, 2011; Fowler, 2014). This limitation was overcome in the research by collecting email addresses by phone and offering those without internet access to receive the kitchen diaries by post.

6.5.3.2. Interviewer errors and processing errors

Online data collection involves the danger of information losses because of technical failure. The current research suffered at least one such failure, as the web portal did not send automatic email reminders when requested in all instances. Also, it is possible that some emails sent to participants with their passwords to the online portal were classified as a spam, and hence did not reach the participants' inbox. Additionally, it is possible that some data was lost because participants failed to save their reporting and/or made some sort of typing errors.

On the other hand, online research has the advantage that information does not need to be manually entered into the statistics software, which saves time and prevents misreading and typing errors by the researchers.

6.5.3.3. Measurement errors

The participants were asked to measure the food waste using two different scales: the waste of solid food was to be measured in grams, but the waste of liquids and oil in decilitres. An inspection of the data did not reveal any extreme outliers in the measurement of solid food, but there were some extreme outliers in the measurements of liquids and oil. In total, 15 of the homes had filed one or more measurements of their liquid waste as ≥ 50 dl. As these outliers skewed the results of the waste of these factors considerably, it was decided to contact the relevant participants by phone to obtain their confirmation that the filing was correct. The researchers succeeded in contacting 10 out of 15 homes that had filed such extreme outliers. All confirmed measurement errors, saying that they had accidentally filed the amounts in grams/millilitres instead of decilitres. Consequently, it was decided to rectify the assumed measurement errors for all 15 homes.

7. Results of Household Research

Although the households were asked to file their food waste into the kitchen diary for a whole week, not all of them did so some filed for a longer period and others for a shorter one (see Table 2):

Table 2. Frequency of filing days for households

Number of filing days	Frequency (N)	Percentage (%)
1	6	6.7
2	2	2.2
3	1	1.1
4	3	3.3
5	4	4.4
6	2	2.2
7	53	58.9
8	13	14.4
9	1	1.1
10	2	2.2
14	1	1.1
18	1	1.1
22	1	1.1
Total	90	100

Because of this variation in the length of the filing period, it was necessary to calculate the food waste per household per day (Fw) for each type of food waste before any further calculations:

Fw [g] = g [g]/N

g = Total food waste of household for each food waste category

N = Number of filing days

The results for the average person per day of waste of edible food, inedible food, cooking oil and liquid poured into the sewage, as well as the standard deviation and the standard error, are presented in Table 3.

Table 3. The average person per day waste of edible food, inedible food, cooking oil and liquid

Type of food waste	N	Mean	SD	SE	Minimum value	Maximum value	Range
Edible food	90	54.0 g	56.8	6.0	0 g	262.7 g	262.7 g
Inedible food	90	68.8 g	67.2	7.1	0 g	358.7 g	358.7 g
Cooking oil	90	0.1 dl	0.8	0.1	0.0 dl	7.1 dl	7.1 dl
Liquid	90	1.1 dl	5.4	0.6	0.0 dl	48.2 dl	48.2 dl

The upper and lower CI bounds of the average person per day waste are presented in Table 4.

Table 4. The average person per day waste of edible food, inedible food, cooking oil, and liquid with upper and lower CI bounds

Type of food waste	N	Mean	SD	SE	95% CI	
					Lower bound	Upper bound
Edible food	90	54.0 g	56.8	6.0	42.1 g	65.9
Inedible food	90	68.8 g	67.2	7.1	54.8 g	82.9 g
Cooking oil	90	0.1 dl	0.8	0.1	0.0 dl	0.3 dl
Liquid	90	1.1 dl	5.4	0.6	0.0 dl	2.2 dl

7.1. Food waste per person per week

Household food waste is often measured as per person per week (Jörissen, Priefer, & Bräutigam, 2015). Thus, for the purpose of comparison, the results on household food waste per person per week are presented in Table 5.

The waste per person per week (pww) was calculated by multiplying the person per day waste (pdw) by seven:

pww [g] = pwd [g] * 7

Table 5. The average individual per week waste of edible food, inedible food, cooking oil, and liquid

Type of food waste	N	Mean
Edible food	90	377.8 g
Inedible food	90	481.8 g
Cooking oil	90	1.0 dl
Liquid	90	7.7 dl

7.2. Annual food waste per person

Household food waste has also been measured as kilograms of food waste per person per year (Stenmarck et al., 2016).

The waste of edible and inedible food per person per year (pwy) is calculated as follows:

pwy [kg] = (pwd [g] * 365.25)/1000

Initially, the waste of cooking oil/fat was measured in decilitres. Therefore, the average density of cooking oil (92.8 g/dl) had to be taken into account when calculating the waste in kilograms per person per year:

pwy (kg) = ((pwd [dl]*92.8[g/dl])* 365.25)/1000

In the calculation of the waste of liquid per person per year (pwy) it is assumed that one litre equals one kilogram:

pwy (kg) = (pwd [dl] * 365.25)/10

The results are illustrated in Table 6.

Table 6. The average annual waste per person of edible food, inedible food, cooking oil and liquid

Type of food waste	N	Mean (kg)
Edible food	90	19.7
Inedible food	90	25.1
Cooking oil	90	5.1
Liquid	90	40.4

7.3. Annual household food waste in Iceland

In the third quarter of 2019, the population of Iceland (P) was 362,860 individuals, according to Statistics Iceland.

The annual waste of edible and inedible food (afw) in Iceland is measured in tonnes, and was calculated as follows:

afw [tonnes] = (pwd [g] *365.25*P)/1.000.000

The annual waste of cooking oil and fat (afw) in Iceland is measured in tonnes, and was calculated as follows:

afw [tonnes] = (pwd [dl] *92.8 [g/dl]*365.25*P)/1.000.000

The annual waste of liquid was calculated as follows:

afw [tonnes] = (pwd [dl] *365.25*P)/10.000

The results of the calculations of the annual food waste in Iceland are illustrated in Table 7.

Table 7. The total annual waste of edible food, inedible food, cooking oil, and liquid

Type of food waste	N	Annual waste (tonnes)
Edible food	90	7152.2
Inedible food	90	9122.5
Cooking oil	90	1840.0
Liquid	90	14670.3

7.4. Summary of results of household food waste

The results of household food waste in Iceland are summarised in Table 8.

Table 8. Summary of results of household food waste in Iceland

Type of food waste	Person per day food waste	Person per week food waste	Person per year food waste (kg)	Annual food waste in Iceland (tonnes)
Edible food	54.0 g	377.8 g	19.7	7152.2
Inedible food	68.3 g	481.8 g	25.1	9122.5
Cooking oil	0.1 dl	1.0 dl	5.1	1840.0
Liquid	1.1 dl	7.7 dl	40.4	14670.3
Total			90.3	32785.0

The results reveal considerable food waste within Icelandic households. Regarding edible food, each individual wastes 54.0 g a day, which adds up to 19.7 kg a year, or an annual waste of 7,152.2 tonnes in total. The figures for inedible food that are disposed of are somewhat higher: 68.3 g a day, or 25.1 kg a year, and total annual waste of 9,122.5 tonnes. Each individual throws away 0.1 dl of cooking oil and fat and 1.1 dl of drinks and food in a liquid form per day, or annually 5.1 kg and 40.4 kg respectively. In total, Icelandic households pour down the drain 1840.0 tonnes of cooking oil and fat, and 14,670.3 tonnes of drinks and other liquid food a year. Overall, 90.3 kg of food and drink is disposed of per person per year, or 32,785.0 tonnes in total.

7.5. Comparison with other results of household food waste

The datasets of the household part of the 2016 Icelandic Food Waste Researach and the household part of the current research were merged, to examine whether the differences in the waste of edible food, inedible food, liquid, and cooking oil between the years 2016 and 2019 were statistically significant.

A test of normality was applied to examine whether the food waste variables were normally distributed, and whether to use a parametric or non-parametric test to examine the residence difference (see Table 9).

Table 9. Tests of normality for person per day waste of edible food, inedible food, cooking oil and liquid, by residence

Type of food waste	Residence	Test of Normality
Edible food (Equal variances assumed)	2016	D(123) = .167. p = .000
	2019	D(90) = .171. p = .000
Inedible food (Equal variances not assumed)	2016	D(123) = .169. p = .000
Cooking oil and fat (Equal variances not assumed)	2019	D(90) = .153. p = .000
	2019	D(90) = .432. p = .000
Liquid (Equal variances not assumed)	2016	D(123) = .363. p = .000
	2019	D(90) = .421. p = .000

As the food waste variables were significantly non-normal in both the urban and the rural groups, the non-parametric Mann-Whitney test was applied to test whether differences between residence exist (see Table 10).

Table 10. Average person per day waste of edible food, inedible food, cooking oil and liquid, by year

Type of food waste	Residence	N	Mean	SD	SE	Test of significance (U)
Edible food	2016	123	62.98 g	65.22	5.88	= 5104.50. p = .332
	2019	90	53.97 g	56.76	5.98	
Inedible food	2016	123	107.23 g	104.94	9.46	= 4217.50. p = .003
	2019	90	68.83 g	67.21	7.08	
Cooking oil	2016	123	0.64 dl	3.06	0.28	= 4883.00 p = .058
	2019	90	0.15 dl	0.81	0.09	
Liquid	2016	123	5.44 dl	14.55	1.31	= 3882.50. p = .000
	2019	90	1.11 dl	5.41	0.57	

In Table 11 the results of the food waste of Icelandic households in 2019 are compared to the results of household food waste in the 2016 Icelandic food waste research.

Table 11. Comparison of results of household food waste in Iceland in 2016 and 2019

Type of food waste	Person per day food waste		Person per year food waste (kg)		Annual food waste in Iceland (tonnes)	
	2016	2019	2016	2019	2016	2019
Edible food	62.98 g	54.0 g	23.00	19.7	7649.31	7152.2
Inedible food	107.23 g	68.3 g	39.17	25.1	13023.75	9122.5
Cooking oil	0.64 dl	0.1 dl	21.69	5.1	7213.53	1840.0
Liquid	5.44 dl	1.1 dl	198.67	40.4	66072.18	14670.3
Total			282.56	90.3	93958.77	32785.0

Table 11 reveals a considerably lower total annual food waste in Iceland in 2019 than in 2016. However, the main differences are between the waste of cooking oil and liquids. It is important to note that the measurement of those waste factors in the 2016 research must be taken with the warning that the data was not inspected for measurement error. As discussed in subchapter 6.5.3.3, the inspection of the 2019 data revealed some measurement errors that needed to be rectified. It can be expected that similar but un-rectified measurement errors were also the case in the 2016 data, and consequently that the 2016 results on cooking oil and liquid waste are over-estimated.

Regarding comparisons between countries, it should be noted that results vary considerably. As such, Jörissen's et al. (2015) review on European studies reveals a range from 153 g – 1500 g per person per week. It can be assumed that the differences can partly be explained by different definitions of food waste. The current results of the waste of edible food in Iceland are identical to the results of Koivupuro et al. (2012) on edible food waste in Finland of 442 g per person per week, when it has been taken into consideration that milk (in liquid form) was included in the Finnish study. The results are also identical to the authors' estimate of the FUSIONS projects of 92 ± 9 kg per person per year within the EU-28 (Stenmarck, Jensen, Quested, and Moates, 2016). Drinks and food in liquid form are included in that estimate.

8. Methods of Company Research

8.1. Sample design

The sample was selected from Statistics Iceland's business register, using a simple random stratified sample design. The strata were based on the NACE categorisation identified in the EU plug-in for food waste statistics, as well as on the number of staff members in each company, splitting each NACE category into two groups of small (< 100 staff members) and big (≥ 100 staff members) companies. NACE categories of the EU plug-in with no economic activities in Iceland were erased from the sample frame. Subcategories of the included NACE categories that apparently do not deal with food were also deleted from the sample frame. The included NACE categories and the inclusion of their subcategories, as well as the number of companies in each group of company size, are listed in Table 12.

Table 12. The NACE categories included in the company sample frame, the inclusion of their subcategories, and number of companies in each group of company size

NACE category	Inclusion of subcategories	Group of company size	
		< 100 staff members (N)	≥ 100 staff members (N)
01 Agriculture	Fully included	396	0
03 Fishing	Fully included	275	9
10.1 Meat processing	Fully included	20	7
10.2 Fish processing	Fully included	118	11
10.3 Processing of fruit and vegetables	Fully included	6	0
10.4 Manufacture of oil and fat	Fully included	2	1
10.5 Manufacture of dairy products	Fully included	13	1
10.7 Manufacture of bakery and farinaceous products	Fully included	48	2
10.8 Manufacture of other food products	Fully included	46	2
11 Manufacture of beverages	Fully included	17	2
46 Wholesale trade	Subcategories assumed not to involve food excluded	123	0
47 Retail trade	Subcategories assumed not to involve food excluded	129	10
55 Accommodation	Subcategories assumed not to involve food excluded	261	6
56 Food and beverage service activities	Fully included	589	8
85 Education	Students' canteens in pre-, primary, and secondary school included	68	0
86 Health	Patients' canteens included	1	10
87 Nursing homes	Patients' canteens included	31	19

All companies in the group of larger companies (≥ 100 staff members) were included in the sample. In the NACE categories where the number of companies in the group of smaller companies (< 100 staff members) was lower than 20, all companies were also included in the sample. Note that in NACE categories 01, 10.3 and 46 no companies had more than 100 staff members which meant that these

categories were merged with categories 03, 10.4 and 47 respectively in the formation of the sample's strata.

The proposed sample size was 700 companies. The number of companies in the strata that were fully included into the sample was 145, leaving 555 units to the strata where randomised sampling was needed, namely the strata of smaller companies within NACE codes 10, 30, 102, 107, 108, 460, 470, 550, 560 og 870. It was decided that the sampling probability for each stratum would be as equal as the error of rounding allowed. The final sample size was 694 companies.

Educational institutions (NACE category 85) were sampled additionally, as their coverage in the business registers is poor. Information on existing pre-schools and primary schools in Iceland was gathered from the Association of Local Authorities, and information on existing secondary schools from the Ministry of Education. Based on that sample frame, 15% of the schools at each school level were selected into the sample, given a final sample size of 68 schools.

8.2. Weighting and substitutions

The data was weighted within each stratum. The group of larger companies in each stratum received the weight 1, as did the group of smaller companies within the NACE categories where the total number of small companies was <20. The weight of the group of smaller companies (x) in other NACE categories is the inverse total number of such companies within the NACE category:

$x = 1/N$

N = number of smaller companies in the relevant NACE

The weighting was adjusted to nonresponse (xx):

$xx = x/rr$

x = NACE category design weight

rr = response rate for each stratum

No substitutions were applied.

8.3. Sampling errors: Standard errors and effective sample size

There were 762 companies in the final sample. In total, 17 of the companies proved to be non-eligible, giving a net sample of 745 companies (see Table 13).

Table 13. Level of participation of company research

Level of participation	N	Percentage
Did not participate	665	87.3
Filed into the diary web portal	72	9.5
Provided available food waste data	8	1.0
Company was not operating or not involved in food	17	2.2
Total	762	100%

8.4. Non sampling errors

Errors other than sample errors can be divided into three categories 1) coverage errors; 2) measurement and processing errors, and 3) nonresponse errors.

8.4.1. Sampling frame and coverage errors

The sampling frame is the Statistics Iceland's business register. Businesses in NACE categories assumed to be involved in food were eligible for the sample. Education institutions were selected separately as their coverage in the business registers is poor. The sample frames of those institutions were lists gathered from the Association of Local Authorities and the Ministry of Education.

8.4.2. Measurement and processing errors

Measurement and processing errors can be classified into three categories, 1) Design errors; 2) interviewer errors, and 3) processing errors.

8.4.2.1. Design errors

As in the case of the household research, an immediate problem in the design of research of food waste in companies is that the filing is time-consuming for the sampled companies. The demands of time and effort by the participants could have led to nonresponse. Also, a lack of necessary facilities, such as a scale, could have led to nonresponse. The company diaries were self-administered, and a researcher was not present to control the quality of the measurements. The measurements are therefore subjective rather than objective (Fowler, 2014, p. 72).

Internet surveys that focus on individuals have been criticised for not reaching those who do not have access to an internet connection (e.g. Brick, 2011; Fowler, 2014). Such a limitation should not be important for company research.

8.4.2.2. Interviewer errors and processing errors

Online data collection involves the danger of information losses because of technical failure. In this case, the data collection did not suffer from such a failure. However, it is possible that data was lost because some participants failed to save their reporting and/or made typing errors. The data from the education institutions were inspected for such errors. One typing error where the waste had been filed in grams instead of kilograms was detected and rectified. Regarding the data from companies within other NACE codes, such an inspection was not possible due to the wide range of sizes of the companies with each NACE code.

Online research has the advantage that information does not need to by manually filed into the statistics software, which saves time and prevents misreading and typing errors by the researchers.

8.4.3. Nonresponse errors

Nonresponse errors were not accounted for.

8.4.3.1. Achieved sample size, and unit nonresponse

Achieved sample size was 745 companies, of which 665 (89.3%) did not participate, 72 (9.7%) participated by filing data into the diary web portal, and 8 (1.1%) participated by submitting their already available data on food waste. Table 14 illustrates the general status of participation of companies in the research, and Table 15 that status broken down by NACE codes.

Table 14. Status of participation in the research

Status of participation	N	Percentage
Did not participate	665	89.3
Filed into the diary web portal	72	9.7
Provided available wastage data	8	1.1
Total	745	100%

Table 15. Status of participation in the research by NACE code

NACE code	No participation	Filed into portal	Available data	Total
01 Agriculture	98.1% (103)	1.9% (2)	0.0% (0)	100.0% (105)
03 Fishing	95.4% (83)	4.6% (4)	0.0%(0)	100.0% (87)
11 Manufacture of beverages	94.7% (18)	5.3% (1)	0.0% (0)	100.0% (19)
46 Wholesale trade	95.8%% (23)	4.2% (1)	0.0% (0)	100.0% (24)
47 Retail trade	86.3% (44)	13.7% (7)	0.0% (0)	100.0% (51)
55 Accommodation	93.6% (73)	6.4% (5)	0.0% (0)	100.0% (78)
56 Food and beverage service activities	93.4% (156)	6.6% (11)	0.0% (0)	100.0% (0)
85 Education	60.3% (41)	38.2% (26)	1.5% (1)	100.0% (68)
86 Health service	33.3% (1)	66.7% (2)	0.0%	100.0% (3)
87 Nursing homes	47.6% (10)	28.6% (6)	23.8% (5)	100.0% (21)
10.1 Meat processing	88.9% (24)	7.4% (2)	3.7% (1)	100.0% (27)
10.2 Fish processing	100% (43)	0.0% (0)	0.0% (0)	100% (43)
10.3 Processing of fruit and vegetables	83.3% (5)	16.7% (1)	0.0% (0)	100.0% (6)
10.4 Manufacture of oil and fat	100.0% (3)	0.0% (0)	0.0% (0)	100.0% (3)
10.5 Manufacture of dairy products	85.7% (12)	14.3% (2)	0.0% (0)	100.0% (14)
10.7 Manufacture of bakery and farinaceous products	93.3% (14)	6.7% (1)	0.0% (0)	100.0% (15)
10.8 Manufacture of other food projects	85.7% (12)	7.1% (1)	7.1% (1)	100.0% (14)
Total	89.3% (665)	9.7% (70)	1.1% (8)	100.0% (745)

8.4.3.2. Item nonresponse

It was assumed that those who participated but did not report on some of the food waste types did not waste any such type of food. Such missing values were therefore converted into zero values.

No imputations were applied.

8.5. Mode of data collection

Self-administrated online food waste diaries were used to collect the data of the company part of the 2016 Icelandic Food Waste Research. In general, the collection of that data was a success. Therefore, it was decided to use the same mode of data collection in the current company research, but with the 2016 diary portal updated to the newest digital mode, as was the case for the current household research.

In the grant application, it was proposed to include secondary data from companies willing to provide it if they would otherwise not respond. In total, 8 companies provided such data (see Table 14).

The disadvantage of secondary data is that it did not always correspond to the break-down of the EU food waste plug-in.

Additionally, in fishing, fish processing, manufacture of dairy products, and beverages the minimum amount of data was not collected, consequently no statistics were produced.

8.5.1. Self-administered, online company food waste diaries

The self-administered, online diaries used in the company research were an upgraded version of the online diaries developed for the 2016 Icelandic Food Waste Research. This upgrading of the online diaries was solely technical, and no changes were made in the format of the diary itself. As the EU food waste plug-in defines different food waste categories for different NACE codes, a specific form was provided for the companies within each code.

An example of the on-line food waste diary form for companies is shown in Figure 2.

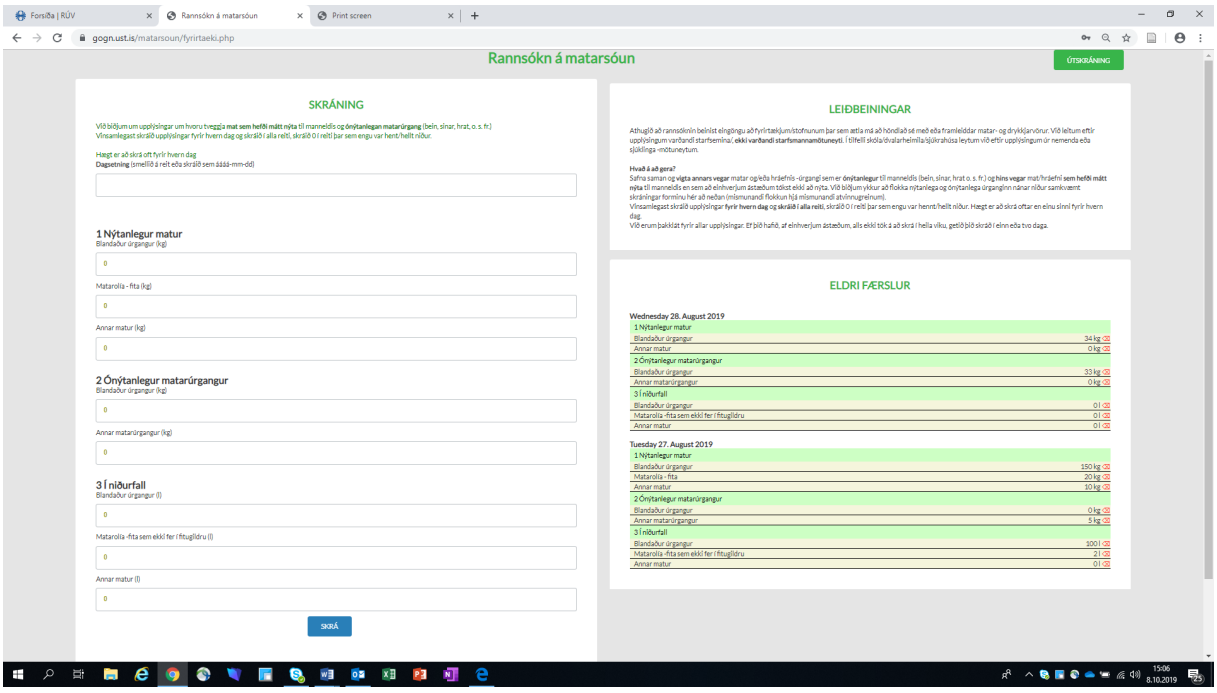

Figure 2. Online kitchen diary form for companies

9. Results of Company Research

9.1. Agriculture (01)

Statistics not calculated because of lack of data.

9.2. Fishing (03)

Statistics not calculated because of lack of data.

9.3. Meat Processing (10.1)

The results on the annual edible and inedible food waste within meat processing in Iceland are shown in Table 16.

Table 16. Annual food waste in meat processing, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food waste (tonnes)	Inedible food waste (tonnes)	Total (tonnes)
02 02 01	Sludge from washing and cleaning	23.8	16977.7	17001.5
02 01 02	Animal-tissue waste	0.0	0.0	0
02 02 03	Materials unsuitable for consumption or processing	0.0	5646.0	5646
02 01 99	Other food waste	145.6	14.7	160.3
Total		169.4	22638.4	22807.8

9.4. Fish processing (10.2)

Statistics not calculated because of lack of data.

9.5. Processing of fruit and vegetables (10.3)

The results of the annual edible and inedible food waste within fruit and vegetable processing in Iceland are shown in Table 17.

Table 17. Annual food waste in processing of fruit and vegetables, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food waste (tonnes)	Inedible food waste (tonnes)	Total (tonnes)
02 03 01	Sludge from washing, cleaning, peeling etc.	0.00	8.74	8.74
02 03 02	Waste from preserving agents	0.00	0.00	0
02 03 03	Waste from solvent extraction	0.00	0.00	0
02 03 04	Materials unsuitable for consumption or processing	0.00	0.00	0
02 03 99	Other food waste	0.01	0.00	0
Total		0.01	8.74	8.74

9.6. Manufacture of oil and fat (10.4)

Statistics not calculated because of lack of data.

9.7. Manufacture of dairy products (10.5)

Statistics not calculated because of lack of data.

9.8. Manufacture of bakery and farinaceous products (10.7)

The results of the annual edible and inedible food waste within bakery and farinaceous product manufacture in Iceland are shown in Table 18.

Table 18. Annual food waste in bakery and farinaceous product manufacture of, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food waste (tonnes)	Inedible food waste (tonnes)	Total (tonnes)
02 06 02	Waste from preserving agents	-	0.0	0
02 06 01	Materials unsuitable for consumption or processing	-	85.8	85.8
20 01 25	Oil and fat	0.0	0.0	0
02 06 99	Other food waste	201.5	11.2	212.7
Total		201.5	97.0	298.5

9.9. Manufacture of other food projects (10.8)

The results of the annual edible and inedible food waste within the manufacture of other food products in Iceland are shown in Table 19.

Table 19. Annual food waste in manufacture of other food products, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food waste (tonnes)	Inedible food waste (tonnes)	Total (tonnes)
02 06 02	Waste from preserving agents	-	0,0	0.0
02 06 01	Materials unsuitable for consumption or processing	-	0.0	0.0
02 06 99	Other food waste	0.2	1.3	1.5
20 01 25	Oil and fat	0.0	0.0	0.0
Total		0.2	1.3	1.5

9.10. Manufacture of beverages (11)

Statistics not calculated because of lack of data.

9.11. Wholesale (46) and retail trade (47)

As discussed earlier, for statistical reasons the smaller companies within the ISAT categories of wholesale (ISAT no. 46) and retail trade (ISAT no. 47) had to be grouped together in one stratum within the company sample. Consequently, the results of these two ISAT categories are presented together in Table 20.

Table 20. Annual food waste in wholesale and retail trade, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 03 01	Mixed municipal waste	1081.9	58.1	982.0	2122
20 01 25	Oil and fat	33.9	62.2	0.0	96.1
20 03 99	Other food waste	90.7	49.7	60.1	200.5
Total		1206.6	170.0	1042.1	2418.7

9.12. Accommodation (55)

The results of the annual edible and inedible food waste in accommodation activities in Iceland are shown in Table 21.

Table 21. Annual food waste in accommodation, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 01 08	Biodegradable kitchen and canteen waste	2453.6	357.5	1214.7	4025.8
20 01 25	Oil and fat	253.7	0	0.0	253.7
20 03 01	Mixed municipal waste	0.0	0	639.3	639.3
20 03 99	Other food waste	0.0	0	0.0	0
Total		2707.2	357.5	1854.1	4918.8

9.13. Food and beverage service activities (56)

The results of the annual edible and inedible food waste within food and beverage service activities in Iceland are shown in Table 22.

Table 22. Annual food waste in food and beverage service activities, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 01 08	Biodegradable kitchen and canteen waste	3604.8	1400.4	31.9	5037.1
20 01 25	Oil and fat	250.2	0.0	44.3	294.5
20 03 01	Mixed municipal waste	212.4	670.6	23.4	906.4
20 03 99	Other food waste	71.8	36.8	0.0	108.6
Total		4139.2	2107.8	99.5	6346.5

9.14. Education (85)

The results of the annual edible and inedible food waste within canteens in educational institutions in Iceland are shown in Table 23.

Table 23. Annual food waste within education. by edibility. in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 01 08	Biodegradable kitchen and canteen waste	1181.1	1237.7	665.9	3084.7
20 01 25	Oil and fat	3.3	0.9	0.0	4.2
20 03 01	Mixed municipal waste	305.9	10.6	86.4	402.9
20 03 99	Other food waste	37.5	15.6	36.8	89.9
Total		1527.8	1264.8	789.1	3581.7

9.15. Health (86)

The method used to calculate food waste in health institutions deviates from the main method of research as it depends on the number of inpatient days per year. Thus, instead of weighting the data, the food waste per inpatient day (fwi) for the institutions that participated in the research was calculated. In the calculation, the variation in the number of filing days was considered, and the standardised weekly food waste calculated before and further calculations:

$fwi = (Fw[kg]/N^1)*7*52/N^2$

fw = food waste in kg

N^1 = number of filing days

N^2 = number of annual inpatient days of participating institutions

To calculate the total annual food waste (afw) within Icelandic health institutions, the food waste per inpatient day of the participating institutions was then multiplied by the total annual inpatient days in Iceland (taid). The information on taid was gathered from the homepage of the Directorate of Health in Iceland, and goes until 2018[2]:

Afw [ton] = (fwi [kg]* taid)/1000

taid = total annual inpatient days at the smaller institutions

The results are presented in Table 24.

[2] See in https://www.landlaeknir.is/tolfraedi-og-rannsoknir/tolfraedi/heilbrigdisthjonusta/sjukrahus/

Table 24. Annual food waste within health institutions, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 01 08	Biodegradable kitchen and canteen waste	51.79	0.93	31.98	84.7
20 01 25	Oil and fat	0.19	0.00	0.00	0.19
20 03 01	Mixed municipal waste	37.46	13.51	0.92	51.89
20 03 99	Other food waste	0.00	0.00	0.00	0
Total		89.43	14.44	32.90	136.77

9.16. Nursing homes (87)

In total, five out of the eleven participating nursing homes only provided data on total solid biological food waste and did not distinguish between edible and inedible waste. In the calculation of total nursing home food waste, it was therefore assumed that: 1) the proportion between edible waste and inedible waste was the same in the homes that only provided data on biological waste as in the homes that provided data on their edible the food waste; 2) the proportion of solid food waste to liquid food waste was the same in the homes that only provided data on biological waste as in the homes that provided data on liquids.

The results of the annual food waste within nursing homes are presented in Table 25.

Table 25. Annual food waste within nursing homes, by edibility, in tonnes

Code of food waste category	Food waste category	Edible food (tonnes)	Edible liquid into sewers	Inedible food (tonnes)	Total (tonnes)
20 01 08	Biodegradable kitchen and canteen waste	139.8	69.8	84.9	294.5
20 01 25	Oil and fat	13.4	4.2	0.0	17.6
20 03 01	Mixed municipal waste	14.3	0.0	0.0	14.3
20 03 99	Other food waste	0.0	0.0	0.0	0
Total		167.5	74.1	84.9	326.5

9.17. Summary of company results

The summary of the results of food waste in companies in Iceland in 2019 is illustrated in Table 26.

Table 26. Summary of results of company food waste in Iceland, annual waste by NACE codes

NACE code	Edible food (tonnes)	Inedible food (tonnes)	Liquid (tonnes)	Oil and fat (tonnes)	Total (tonnes)
Agriculture (01)	No data	No data	No data	No data	No data
Meat processing (03)	169.4	22638.4	-	-	22807.8
Fish processing (10.2)					
Processing of fruit and vegetables (10.3)	0.01	8.74	-	-	8.74
Manufacture of oil and fat (10.4)	No data	No data	No data	No data	No data
Manufacture of dairy products (10.5)	No data	No data	No data	No data	No data
Manufacture of bakery and farinaceous products (10.7)	201.5	97.0	-	0.0	298.5
Manufacture of other food products (10.8)	0.2	1.3	-	0.0	1.5
Manufacture of beverages (11)	No data	No data	No data	No data	No data
Wholesale and retail (46 and 47)	1172.7	1042.1	107.8	96.1	2418.7
Accommodation (55)	2453.5	357.5	1854.1	253.7	4918.8
Food and beverage service (56)	3889.0	55.2	2107.8	294.5	6346.5
Education (85)	1524.5	789.1	1263.9	4.2	3581.7
Health institutions (86)	89.24	32.90	14.44	0.19	136.77
Nursing homes (87)	154.1	84.9	69.9	17.6	326.5
Total annual waste	9654.15	25107.14	5417.94	666.29	40845.51
Person per year food waste	26.6 kg	69.2 kg	14.9 kg	1.8 kg	112.6 kg

It must be emphasised when examining the company research that figures are missing from the NACE codes for agriculture (01), fish processing (10.2), manufacture of oil and fat (10.4), manufacture of dairy products (10.5), and manufacture of beverages (11). The available figures of annual food waste add up to 40845.5 tonnes, or 112.6 kg per person per year. The figures are slightly higher than the estimate of Stenmarck et al. (2016) for the EU-28 of 81 kg per person per year, and where the whole food chain (except for households and institutions) is reached.

Table 27. Summary of results of annual food waste within different parts of the food chain, waste per person per year, and total annual waste

Type of waste	Wholesale and retail (46 and 47)		Food service (55 and 56)		Hospitals and nursing homes (86 and 87		Consumption excluding households		Consumption including households	
	Per person (kg)	Total waste (tonnes)	Per person (kg)	Total waste (tonnes)	Per person (kg)	Total waste (tonnes)	Per person (kg)	Total waste (tonnes)	Per person (kg)	Total waste (tonnes)
Edible food	3.2	1173	17.5	6343	0.7	243	22.4	8110	42.1	15263
Inedible food	2.9	1042	1.1	413	0.3	118	3.6	1320	28.8	10442
Liquid	0.3	108	10.9	3962	0.2	84	14.6	5310	55.1	19980
Oil and fat	0.3	96	1.5	548	0.0	18	1.6	570	6.6	2410
Total	6.7	2419	31.0	11265	1.3	463	42.2	15310	132.5	48095

In Table 27 the results are summarised for different parts of the food chain. As data is lacking for a considerable part of primary production and manufacturing, the results for those is left out. The table shows that wholesale and retail are responsible for 2419 tonnes of the total annual waste, or 6.7 kg per person per year; food service wastes annually 11,265 tonnes in total, or 31.0 kg per person; hospitals and nursing homes waste 463 tonnes, or 1.3 kg per person; and the consumption chain as a whole wastes 15,310 tonnes, or 42.2 kg per person. When household waste is added to the company waste, the total annual waste comes to 48,095 tonnes, or 132.5 kg per each resident of Iceland.

9.18. Comparison with other results on food waste

Table 28. Comparison of results of waste per person per year within different parts of the food chain, in 2016 and 2019

Type of waste	Wholesale and retail (46 and 47)		Food service (55 and 56)		Hospitals and nursing homes (86 and 87		Consumption excluding households		Consumption including households	
	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019
Edible food	3.6	3.2	81.9	17.5	-	0.7	92.2	22.4	115.2	42.1
Inedible food	7.1	2.9	30.2	1.1	-	0.3	38.7	3.6	77.7	28.8
Liquid	0.6	0.3	0.1	10.9	-	0.2	3.6	14.6	202.6	55.1
Oil and fat	0.0	0.3	0.0	1.5	-	0.0	0.0	1.6	22.0	6.6
Total	12.3	6.7	112.2	31.0	1.0	1.3	135.6	42.2	418.6	132.5

Table 29. Comparison of results of total annual waste (tonnes) within different parts of the food chain, in 2016 and 2019

Type of waste	Wholesale and retail (46 and 47)		Food service (55 and 56)		Hospitals and nursing homes (86 and 87		Consumption excluding households		Consumption including households	
	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019
Edible food	1311	1173	29732	6343	-	243	33471	8110	41120	15263
Inedible food	2591	1042	10948	413	-	118	14062	1320	27086	10442
Liquid	217	108	51	3962	-	84	1335	5310	67407	19980
Oil and fat	0	96	0	548	-	18	0	570	7214	2410
Total	4465	2419	40730	11265	356.2	463	49213	15310	143172	48095

In Table 28 the results of waste per person per year and in Table 29 of total annual waste within different parts of the food chain are compared to the results from the 2016 research. The comparison indicates a considerable reduction of food waste within the wholesale, retail, and food service sectors. The reduction is remarkable regarding inedible food in the wholesale and the retail sectors, and for all types of food waste in food service. Consequently, food waste within the company part of the consumption chain was reduced considerably between 2016 and 2019 in all waste types except liquid where the waste tripled. As liquid waste did not constitute a large part of the total waste in 2016, the total food waste also decreased greatly, and total waste within the company part of the consumption chain in 2019 was only a third of what it was in 2016. The reduction within the total consumption chain (households included) is also considerable, due to the notable reduction of waste in the food service

sector and of liquid and oil waste in households. It should be noted that statistical significances of the differences were not calculated. Also, the scale of the reduction within food service could be a consequence of extreme measurement errors in the 2016 data, as is also quite likely for liquid and oil waste in households (see the subchapter on chapter 7.5 Comparison with other results of household food waste).

Regarding international comparisons, the 2019 figures for wholesale and retail are somewhat lower, but the figures for food service are considerably higher than what Stenmarck et al. (2016) estimated for the EU-28 (9 kg and 21 kg per person per year). The magnitude of tourism in Iceland could explain the relatively high figures for food service waste in the country.

10. Annex 1. The developments of the methods

The aim of this annex is to report the development and possible standardisation of the methods used in both the current research on the quantity of food waste in Iceland in 2019 and the 2016 food waste research. As such, the annex meets the second objective of the food waste statistics project. It begins with a discussion of the methodological and practical problems faced in the research and proposes suggestions for solutions to these problems. Based on these suggestions, standardised methods for future research on the quantity of food waste in Iceland will then be offered. In this work, the guideline of the proposal is on finding the most cost-effective and comprehensive measures at all steps of the food chain (Hartikainen, Riipi, Katajajuuri, & Silvennoinen, 2020, p. 419).

In general, statistical methods have a long history and statistics on certain social phenomena have been produced for centuries. Thus, statistics on household budgets can be traced back to the 17th century, and a long tradition of standardised methods for statistics on household budgets exists (Gazeley, Holmes, & Newell, 2018). In comparison, statistics on food waste are brand new. The first attempts to produce such statistics are only a few decades old, the methods on the statistics are still in development, and their standardisation is lacking. However, there has been a growth in research on the quantification of food loss and waste (FLW) in recent years, especially in research on the consumption part of the food chain within Western countries (Xue et al., 2017). Nonetheless, methods on the quantification still need revision, and methods on food waste statistics are still to be standardised (Xue et al., 2017). It is the hope of the author that the annex will facilitate such a standardisation of food waste methods in the Icelandic context, and even in a wider European context.

The main difference between the research design proposed in the annex and the design of the 2016 and 2019 research is that the proposed design is not based on the thorough breakdown of the food waste plug-in. Instead, the food chain is only broken into primary production, manufacturing, wholesale and retail, catering and households; and the waste only broken into edible and inedible waste, solid and liquid waste. Also, it is proposed that the company part of the research will be identified as four different studies instead of one, and that the data collection in primary production and manufacture of food will rest on secondary data. Finally, regarding the wholesale and retail, catering and household studies, it is proposed that the sample will be randomly distributed throughout the year and that each research unit will measure the waste for one day. Such a data collection would allow for the measurement of (assumed) annual fluctuations in food waste, as well as reduce the amount of time the research requires of each participant, and, hence, facilitate a higher response rate.

10.1. Problems and solutions

Below we address the problems faced in both the 2016 and the 2019 Icelandic food waste research and propose solutions to these problems. The problems revolve around the definition of food waste, the sampling and nonresponse rate, data collection and whether to use secondary data, as well as whether the European food waste plug-in is a practical tool for the research on the quantity of food waste.

10.1.1. The definition of food waste, objective or subjective?

It has been repeatedly pointed out that no common definition of food waste exists (Hartikainen et al., 2020; Östergren et al., 2014; Xue et al., 2017). To complicate matters, any definition is composed of various factors. Thus, to be able to define food waste one has to first define what is food, and then to decide whether food waste only includes edible food or whether the inedible parts of food should be included, as well as whether food waste only refers to solid food, or whether liquid and oil should also be included.

When this manifold nature of the food waste concept has been identified, the process of providing an objective definition of food waste is straightforward, and, as such, did not cause any problems. However, the experience of both the 2016 and 2019 research shows that the participants' subjective understanding of food waste could contradict the objective definition to the extent that it can be difficult to argue that the definition holds for the results of the research.

Due to this subjectivity, it was the participants of the research who decided which food was edible or inedible, and whether leftovers that were not thrown away (but fee to animals or composted, etc.) were classified as food waste or not. Some participants commented that they did not consider food utilised for something other than human consumption (especially food utilised as animal feed) as food waste. In addition, some participants also noted the distinction between edible and inedible food and argued that throwing inedible parts of the food away is not waste. Such a difference between the objective and the subjective definitions of food waste could have affected the measurement of the amount of food waste, and, consequently, influenced the validity of the results.

One solution to such differences between the objective definition and subjective understanding of food waste could be objective measurements of the waste: observers would measure the waste instead of the participants. An obvious hindrance of this solution is financial, as it would be costly to provide the necessary personnel and devices for such an objective measurement, at least if requirements of a representative sample are to be met. Another obstacle to objective measurements is the observers' access to the food waste. It is one thing to consent to weighing and filing the food waste diary of your home/company, but it is another thing entirely to consent to allow observers access to that space.

Regarding household food waste, the latter obstacle has been solved by providing 'caddies' into which the participants put the waste and leave outside their home (Elimelech, Ayalon, & Ert, 2018). However, caddies do not solve the financial cost of objective measurements, as they require outside space where they can be stored and they would have to be sturdily built to withstand the extreme weather conditions that are often the case in Iceland.

In light of the financial and practical benefits of subjective measurements, we do not recommend that objective measurements should replace subjective measurements in the future. Indeed, the study of van Herpen and van der Lans (2019) supports this argument. They assessed the validity of five methods to measure (edible) household food waste, including subjective diaries and kitchen caddies. Their results reveal that these two types of measurement were ´relatively highly correlated' (p. 71).

Finally, the word waste (*sóun*) itself holds a negative connotation. As such, some participants, especially spokespeople of the companies within the food production sectors, criticised the use of this word in the research, and a few were not even willing to use it. Therefore, we started to use the word loss (*rýrnun*) together with the word waste when addressing food waste within the food production sectors and recommend the use of the word loss in the context of food production in the future.

10.1.2. Sampling methods

It has been identified that data representation is often poor in food waste studies (Hartikainen et al., 2020; Xue et al., 2017). In theory, this is not a problem of the Icelandic food waste studies, as statistical requirements for random sampling and sample size were met. However, low response rates reduced the representation, or generalisability, of the results. Also, the sampling did not cover seasonal fluctuations of food waste. These problems and how they can possibly be solved will be discussed below, as will the incompleteness of the sample frame of the company research and the solution to that incompleteness.

Household research: The Icelandic Population Register is an optimal sample frame for research on household food waste, as it allows for a one one-stage simple sample of family numbers (Fowler, 2014). Such sampling methods were used in both the 2016 and the 2019 studies, and it is advised to use the same method in future research. Also, the confidence level of 99% and confidence interval of ±4% meet statistical requirements without an excessively costly sample size, and, as such, their use could be continuous. That said, the method of randomly distributing the units throughout the year, as suggested below, could possibly entail a larger sample size.

As seasonal fluctuations can be expected in the amount of household food waste, it is suggested that the sample units be randomly split into equal groups in the future, and those groups then randomly distributed throughout the year, identically to what is practiced in the Icelandic Household Budget Survey (Statistics Iceland, n.d.-c). In addition to covering seasonal fluctuations in household food waste, such distribution of the sampling units allows for the filing period to be shortened. In order to cover smaller fluctuations, the participants of the current research were asked to file their amount of

food waste for one week. The method of randomly distributing the sample units throughout the year should also cover such smaller weekly/monthly fluctuations. Thus, the method also allows for shortening the filing period to one day which, in turn, should facilitate a higher response rate.

Company research: The sampling of company research is more complicated than that of household research. Firstly, the food waste plug-in rests on a rather detailed breakdown of companies based on NACE codes that again require a thorough stratification of the sample. The experiences of both the 2016 and the 2019 research show that such complete stratification can lead to violations of both statistical prerequisites and statistical confidentiality. Therefore, a rougher breakdown of NACE codes is suggested for future research, as is discussed in more detail in the subchapter The Food Waste Plug-in.

Secondly, the use of the Statistics Iceland' business register as a sample frame produced certain problems. Firstly, the extent of coverage of education and health institutions in the business register is poor, so other sample frames were needed. Secondly, the register treats big companies as one unit although those companies are usually constituted of many operational units. The experience in both the 2016 and the 2019 research shows that even if the CEO of such companies accepts the general participation of the company in the research, it is unrealistic to expect that all operational units of the company will participate. In both the 2016 and the 2019 research, we solved this problem by taking random samples of the company's operational units. However, the CEOs were not always willing/able to accept this random sampling and just picked out convenient units. Of course, this violated the basis of random sampling, and thus can have affected the validity of the results.

To solve the problems of the sample frame in the company research, we propose that in the future the sample frame that the Statistics Iceland business register offers be manually sorted - as was indeed partially done in both the 2016 and 2019 research. The question of whether operational units of big companies should be treated as separate units within the frame should be carefully considered.

10.1.3. Nonresponse

Both the household and the company research suffered a high nonresponse rate, and the main challenge of future research is how to raise the response rate.

Household research: The execution of both the 2016 and the 2019 research revealed that nonresponse occurs at two stages (see Table 1): firstly, at the consent to participate; and, secondly, at the time of filing. Residents of Iceland are not as willing to participate in research as they were just a few decades ago, with the consequence that response rates in general have dropped. It can be assumed that this trend affected the first stage of nonresponse, and it would be difficult to figure out how a single researcher/research team could have reacted to that trend. Nevertheless, we want to emphasise that necessary precautions were taken in the preparation of the research to avoid nonresponse.

However, we recognise two factors that could be changed in the future in an attempt to lower first-stage nonresponse. It could help if the agency that is responsible for the research had a call centre and

could manage the collection of participants' consent. In the current research the collection was outsourced, but it can be expected that an official institution, such as the Environmental Agency of Iceland, would hold more authority and respect of the public than private research companies. At least, that is the experience of Statistics Iceland. Unfortunately, as of now, the Environmental Agency does not have the resources to form a call centre, and therefore the outsourcing of the telephoning was necessary. In addition, in the future it would help to reduce the amount of time that the research requires of the participants.

The factor of time consumption that the research requires from the participants also relates to the second-stage of nonresponse. In both the 2016 and the 2019 studies the participants who had consented to participate but had not filed into the diaries before a certain period were contacted by phone. In both studies the most common explanations provided for the nonresponse was forgetfulness and lack of time. Thus, the most urgent challenge for future research regarding both first-stage and second-stage of nonresponse is how to reduce the time that the participants need to spend weighing and filing of the food waste.

A solution to the time consumption could be to reduce the filing of the kitchen diaries from one week to one day per participant unit. Part of that solution could also be to randomly distribute the sample throughout the year, as is done in the Icelandic Household Budget Survey (Statistics Iceland, n.d.-c). In recent Dutch research, an identical method was used, although each unit was two random sampling days (which could also be a possibility here) (van Dooren, Janmaat, Snoek, & Schrijnen, 2019). Such a random distribution of the sample would solve another methodological problem, that of the measurement of annual fluctuations of food waste, as has already been discussed in the subchapter Sampling methods.

Company research: In general, the same solutions to nonresponse are suggested for the company research as for the household research: firstly, the agency responsible for the research will conduct the collection and remind the participants instead of the execution being outsourced; and, secondly, the length of the filing period should be reduced to one day and the sample should be distributed throughout the year. However, the detailed stratification of the company sample that the food waste plug-in requires could hinder such a distribution throughout the year as there are very few Icelandic companies with most of the plug-in NACE codes to allow for such a distribution. That problem could be solved by merging NACE codes and reducing the strata of the company sample, as will be discussed further in the subchapter The Food Waste Plug-in.

Also, the long hierarchical and spatial distance within big companies between those staff members who have the power to consent to participate and those staff members who conduct the weighing and filing of the food waste might have added to the nonresponse in the company research. However, we do not have any immediate solution to that problem.

Another possibility to reduce the amount of time that the participants must put into the weighing and filing of the food waste would be to limit the research to an estimate of edible food waste. We suggest

that in the design of future research it be carefully considered whether the information on inedible food waste is needed, or whether such information could be collected through other channels, e.g. by waste-composition analysis. This applies to both the household and the company research.

10.1.4. Data collection

The main challenge in all research is to strike a balance between statistical accuracy and the financial cost of the research (Fowler, 2014). Regarding the research on the quantity of food waste, Jörissen et al. (2015) point out that data collection by a third party has the advantage of being both accurate and objective. However, this method of data collection has severe financial disadvantages: it is expensive to provide an observer for each unit taking part in the research if the sample is large enough to satisfy the statistical demands of confidence level (≥ 99%) and confidence interval (±4%, or less). Therefore, many studies on the quantity of food waste have opted for self-administered data collection despite the fact that this method challenges the objectivity of the measurements (Särndal, Swensson, & Wretman, 1992).

In an attempt to reduce financial costs, self-administered data collection was chosen in the current research. However, the simplest form of self-administered data collection - that of a questionnaire where the respondents are asked to estimate the weight of the food waste - was not chosen as it has been proven that people tend to underestimate how much they waste when self-reporting (Beretta, Stoessel, Baier, & Hellweg, 2013; Jörissen et al., 2015; van Herpen & van der Lans, 2019). To avoid that disadvantage, self-administered diaries were chosen and the participants in both the household and the company research were asked to weigh the waste and file the results into the relevant on-line diary.

On-line data collection has become the norm in research of all kinds. This type of data collection is time-saving for the researchers as compared to older forms of data collection on paper (Fowler, 2014). In light of that advantage, as well as the fact that more than 95% of Icelanders have access to an internet connection (https://hagstofa.is/media/43822/hag_150123.pdf, p. 1), it was decided in the 2016 research to have the diary form be on-line, and to let the on-line portal support both personal computers and smartphones. In general, the experience of the on-line forms has been positive, and it is advised to use the same/identical portal in future research on the quantity of food waste in Iceland. Nevertheless, for future research, a typing error/measurement error check in the filing forms needs to be created. Such a check would reduce typing and processing errors, and increase the validity of the data.

10.1.5. Measurement errors and units of measurement

The household research suffered one type of measurement error that needs to be addressed. The waste of solid food was to be measured in grams, but the waste of liquid and oil in decilitres. An inspection of the data revealed some extreme outliers in the latter measurements, which were

subsequently confirmed in conversations with participants to be the consequence of measurement errors. The liquid/oil waste had been accidentally filed in grams/millilitres instead of decilitres.

As digital scales that measure the weight of liquids have become widespread within Icelandic homes, a solution to this problem is simply to ask participants to measure the liquid waste in grams in the future.

Both the household and company research revealed a problem regarding zero-values. Some explained their nonresponse as their household/ company not wasting any food. It seems that they assumed that zero-values were not 'valuable' for the research. Similarly, some company participants assumed that they did not have to file into the on-line portal on days when nothing had been wasted. This occurred despite instructions that zero-values were 'valuable' results and should be filed.

Although we do not see any obvious solution to this problem, clearly the problem must be addressed in the development of error checking the on-line diaries.

10.1.6. Secondary data

One of the purposes of this annex was to estimate whether and in which instances secondary data can be used in research on the quantity of food waste in Iceland. The discussion below is divided in two segments. The possibilities of using secondary data in future research on food loss in fishing and the fish industries are discussed in one, and the use of such data within other parts of primary production and manufacture in the other.

Fishing and the fish industry is a fundamental part of the Icelandic economy. In keeping with that importance, Statistics Iceland publishes accurate catch figures every month (Statistics Iceland, n.d.-b). The proportion of the catch that is utilised in the Icelandic fish industry has also been thoroughly calculated. Taken together, these figures provide a substantial base for the calculation of food loss within fishing and fish manufacturing in the country, and were utilised in both the 2016 and the 2019 research. We advise that the same method be used in the future. Notably, such data cannot be broken down into edible and inedible food loss, as only the total biological loss is presented.

Other primary production and manufacturing: Both the 2016 and the 2019 research suffered from a lack of data within primary production and manufacturing. This lack of data added to (and probably also interplayed with) the fact that only a handful of companies operate within some NACE codes in Iceland, as has already been discussed in the subchapter Sampling methods and will be touched on again in the subchapter The Food Waste Plug-in.

As a solution to this lack of data in primary production and manufacturing, we suggest that the NACE codes of the food waste plug-in not be used in future research, and even that the NACE codes within primary production and within manufacturing be merged together (see the subchapter The Food Waste Plug-in). Secondly, we suggest collaboration between researchers and actors within these parts of the food chain in order to develop efficient data collection, as has been done in Finland (see in

Hartikainen et al., 2020). The reason for this suggestion is that the execution of the 2016 and 2019 research studies do not leave us with enough experience to fully develop future research methods for this part of the food chain.

Finally, we want to mention than it has become more and more common that companies conduct green accounting. In the more distant future it is quite possible that such green accounting will become obligatory. Any legal obligation for green accounting could ease the collection of secondary data for food waste statistics, as sampled companies would be obliged to provide the relevant information from their green accounting, which is what is already being done in the collection of data for The Icelandic Survey on Wages, Earning and Labour Costs (Statistics Iceland, n.d.-d).

10.1.7. The Food Waste Plug-in

One of the purposes of both the 2016 and 2019 research was to break down the data and the results in accordance with the food waste plug-in. The purpose is in line with the premises of the Eurostat grants that funded the research. The experience from the research shows that some of the flaws of the plug-in can be related to the detailed breakdown of the data/results that the plug-in requires. Therefore, it is suggested that the design of future research will not rest solely on the plug-in. Instead, a rougher breakdown of both NACE codes and waste categories is suggested. Notably, rougher breakdowns would only affect the company research. Further reasoning for not using the plug-in is provided below.

The detailed breakdown into NACE codes in a country with as small population as is the case of Iceland means that there were quite a few or even no companies within some strata of the company sample. As such, three NACE codes had to be merged with another NACE code in the sampling, as those codes did not contain any big companies (as defined by the sampling method) (see subchapter Sample design). In addition, some NACE codes proposed in the plug-in were automatically excluded from the sampling as no companies operate within those codes in Iceland. In other words, in practice, it was not possible to break down the data in as detailed a way as the plug-in required.

The detailed breakdown into NACE codes in a country with as small population as is the case of Iceland also challenges the premise of statistical confidentiality. Such a detailed breakdown of the results can easily reveal the food waste of a company that dominates the market within certain NACE codes. A rougher breakdown of NACE codes would facilitate the requirement of statistical confidentiality. Indeed, it can easily be argued that the premise of statistical confidentiality does not allow for too detailed a breakdown of the results.

The thorough breakdown of the waste categories that the plug-in requires also creates some problems. Firstly, it complicates the filing of the food waste that could then lead to nonresponse. Secondly, it also complicates the analysis of the data which in turn could reduce the validity of the results. The thorough breakdown of the waste categories that the plug-in requires can also hinder the use of secondary data, as such data is usually not broken down according to the plug-in (see the 2016

Final methodological report, sect. 7.5). Thus, in future research, it should be considered what kind of information on waste categories is indeed needed, and the data only broken down according to that need.

In summary, we suggest that the food waste plug-in not be used in future research on food waste in Iceland. Instead, the food chain should be broken down into primary production, food manufacturing, wholesale and retail, restaurants and catering, and households, identical to what was done in a recent Finnish study (Hartikainen et al., 2020). Also, the data should only be broken down into waste categories that are relevant to the reduction and recycling of the waste.

10.2. Proposal of standardised methods

Below we propose a research design of standardised methods of food waste quantification in Iceland. The proposal is based on the experience of the 2016 and 2019 Icelandic food waste research. The research design is illustrated in Table 28.

Table 30. Future design of research on the quantity of food waste within the whole food chain

Research factors					
Definition of food waste	Edible and inedible food waste in both solid and liquid form, and cooking oil and fat				
Breakdown of research	Study 1	Study 2	Study 3	Study 4	Study 5
Field of food chain	Primary production	Manufacture	Wholesale and retail	Catering	Households
Sampling	The whole population	The whole population	Simple random stratified sample	Simple random stratified sample	One-stage simple random sample
Distribution of sample	-	-	Randomly distributed throughout the year	Randomly distributed throughout the year	Randomly distributed throughout the year
Filing period of each unit	-	-	One day	One day	One day
Sample units	-	-	Operational units	Operational units	Family numbers
Sample frame	-	-	Relevant NACE categories of Statistics Iceland's business register	Relevant NACE categories of Statistics Iceland's business register, and other official records if needed.	The Icelandic Population Register
Data collection	Secondary data	Secondary data	On-line filing of food waste	On-line filing of food waste	On-line filing of food waste
Length of data collection period	One year	One year	One day	One day	One day
Data analysis	Descriptive statistics	Descriptive statistics	Inferential statistics	Inferential statistics	Inferential statistics
Results	Statistics on food waste in primary production	Statistics on food waste in manufacture	Statistics on food waste in wholesale and retail	Statistics on food waste in catering	Statistics of household food waste
Deliverables	Statistics on food waste within the whole food chain				

The main difference between the proposed research design and the design of the 2016 and 2019 research is that the proposed design is not based on the food waste plug-in. Instead of breaking the food chain down thoroughly into NACE codes, the chain is only divided into primary production, manufacturing, wholesale and retail, catering and household (see in Hartikainen et al., 2020). Also, in the proposed design the waste is not separated into detailed EWC-Stat waste categories.

Another difference between the proposed design and the design of the former research is that the company part of the research is now identified as four different studies instead of one study. That facilitates the use of a distinct research design for the separate parts of the food chain, and provides the possibility that each part of the chain be examined at different time periods.

The third disparity between the proposed design and the former design is regarding the data collection in primary production and manufacturing of food. It is proposed that the data collection rest on secondary data instead of sampled primary data. Here, it is worth recollecting that we also propose collaborating with actors within these sectors of the food chain, and that collaboration could alter the proposed design of study 1 and study 2. Also, the proposed design of those two studies does not address the fact that secondary data for food loss in fishing covers both the primary production of fishing and the manufacture of fish products. If such data will be used in future research, as was suggested in the subchapter on secondary data, the primary production and manufacturing of fish (at least) must be merged in the results.

Fourthly, regarding studies 3 to 5 it is proposed that the sample be randomly distributed throughout the year, instead of only measuring the food waste at one point in time as was the case in the former studies. On the other hand, it is proposed that each research unit measure the waste for one day instead of one week as was the case before. Together these changes of the research design would solve two types of problems. Firstly, they allow for the measurement of (assumed) annual fluctuations in food waste which the former research design did not capture. Secondly, they would reduce the amount of time the research requires of each participant, and, hence, facilitate a higher response rate.

Finally, we want to mention the possibility of more mixing of research methods. Thus, it would be possible to limit the research proposed here to the examination of the waste of edible food. That would simplify the research and reduce the amount of time the participants have to spend to a greater extent than could be done by solely decreasing the filing period from one week to one day. Information on total biological waste could then be collected by composition analysis, and the extent of inedible food waste estimated form the two types of data. The benefit of such mixing would be more accurate data, the drawback would be higher financial costs.

11. Annex 2. Metadata

Contents:

Registration entry for subjects

Name

Food Waste Statistics for Iceland in 2019

Subject area

Food waste

Responsible authority; office, division, person etc.

Birgitta Stefánsdóttir
Department for Climate and Green Communities
Environment Agency of Iceland
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Purpose and history

The purpose is to gather information on food waste from the whole food use hierarchy in Iceland for the year 2019. The survey is the second of its kind in Iceland. The methods are identical to the methods used in the 2016 Icelandic Food Waste Survey. The food waste statistics are broken down in line with the EU food waste plug-in. Otherwise, the methods of the survey are not comparable to the methods used for food waste statistics in other countries.

Users and application

The research provides information on the amount of food waste in Iceland in 2019 from the whole food chain, from both households and companies that produce, trade, and/or serve food.

Sources

The food waste research is a sample study.

Sources can be divided into three categories: household food waste diaries, company food waste diaries, and available data from companies.

Legal bases for official statistics

The research is a pilot study without a legal grounding, but founded by Eurostat, grant proposal number: 831322 — 2018-IS-FoodWaste — ESTAT-PA8-2018/ESTAT-PA8-2018-2.

Response burden

Those in the sample can choose not to respond.

Respondents keep accurate food waste diaries for one week. The response burden for participants is therefore sizeable, although available data from companies can be used in some instances.

EEA and EU obligations

No formal treaties or rules.

Contents

Description of contents

The food waste surveys give exact and itemised information on food waste of both households and companies in Iceland. The following can be found in the surveys:

annual food waste of households;

annual food waste in food production;

annual food waste in food wholesale and retail;

annual food waste in food service.

The annual food waste is divided into the EWC-Stat waste categories.

Sample of households: The sample consisted of 1067 families chosen at random from family numbers in the National Register of Persons.

Data collection of households: Information on the amount of food the households waste.

Sample of companies: The sample consisted of 762 companies chosen at random from strata within the Statistics Iceland's business register. The strata were based on the NACE categorisations identified in the EU plug-in for food waste statistics, as well as on the turnover of each enterprise, making the total number of strata 27.

Data collection of companies: Information on the amount of food wasted within each NACE category.

The food waste amount is also divided into the EWC-Stat waste categories.

Statistical concepts

The research unit of the household survey is households. The sample is drawn on a random basis from the National Registry of Persons. The family identity number of people aged 18 and older are chosen irrespective of residence or marital status. Participants are all those living in the selected household.

The research unit of the company survey is companies that produce, trade and/or serve food.

Household: All individuals living under the same roof and running a common household while the survey was being conducted.

Company: Company units as defined in the Statistics Iceland's business register.

Food: Any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be eaten by humans. Food is further divided into edible food and inedible food.

Edible food: Has, or had, the potential to be eaten by humans. The definition recognises food which is no longer considered edible since it is mouldy, rotten, past its expiry date, etc., but which has had the potential to be eaten even though it is not edible at the point of disposal.

Inedible food: The part of food that is not recognised as fit for human consumption, such as bones, eggshells, peels, coffee grounds, etc.

Time

Reference period

The research was cross-sectional.

Process time

The research was conducted in August to October 2019, and the reference period is the year 2019.

Frequency of releases

As the research was cross-sectional the results were only released once, in February 2020.

Reliability and security

Accuracy and reliability

The Food Waste Research is a sample survey and entails a degree of uncertainty because of the nature of sample surveys.

Sources of errors

Sampling errors. Every sample research study entails a degree of uncertainty because of the sample not being an exact reflection of the entire registry or population. Due to the random nature of this uncertainty, it is possible to calculate the confidence limits for the numbers being estimated.

Coverage errors. In some cases, the sampling frame does not reflect the actual population. Either there is over-coverage when there are sample units in the frame that should be excluded or there is under-coverage when there are sample units that ought to be assigned to the population but are not in the frame.

Non-response errors. In all surveys, results may represent errors because of non-response in the sample being unevenly distributed among groups. The main reasons for non-response are refusals, hindrances due to illness or disability, absence from home/work while the survey is proceeding, or a failure to find the residence or telephone number of those in the sample.

Interviewer and processing errors. The data was collected on-line. On-line data collection involves the danger of information losses due to technical failure. It is also possible that data was lost because some participants forgot to save their reporting and/or made typing errors.

Design errors. The filing of food waste is time consuming. The demands of time and effort the

participants had to put into the survey can lead to nonresponses. The design required minimal calculating and writing skills in mathematics, which means that those without such skills might be under-covered.

Comparison

Comparison between periods

The research is cross-sectional and conducted for the second time in Iceland. The results are comparable with the 2016 Icelandic Food Waste Research.

Comparison with other statistics

The EU plug-in for food waste statistics was used as a reference for the surveys. A standardised EU procedure for food waste statistics is still in development, and, hence, the results are not comparable with other statistics on food waste within the EU.

Coherence between preliminary and final statistics

Preliminary statistics are not published.

Access to information

Forms of dissemination

News released on the website of the Environmental Agency of Iceland.

Statistics: categorised statistical web tables stored.

Basic data; storage and usability

The source material is stored in digital form by the Environment Agency of Iceland. No access is allowed to the data itself, but it is possible to have it processed on demand.

Reports

The results are explained in the report Food Waste Statistics for Iceland in 2019: Final Methodological Report.

Other information

Further information is provided by:
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Telephone: 5912000.

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