ENVIRONMENT AGENCY OF ICELAND

Food Waste in Iceland 2022

Final methodological report

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ENVIRONMENT AGENCY OF ICELAND

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Abstract

One third of food produced worldwide ends up as food waste.[1] Food waste is an environmental, economic and social problem. The Icelandic Government has implemented an action plan on food waste, *Minni matarsóun*, in which the Environment Agency of Iceland was tasked with providing regular measurements on food waste in the whole value chain of food using a methodology common to the European Union (EU). Iceland has a goal of reducing food waste by 30% in the year 2025 and by 50% in the year 2030, compared to the reference year 2022. To help achieve these targets, the Environment Agency of Iceland has a waste prevention project, *Saman gegn sóun,* which has focused on food waste reduction with campaigns, educational posters, teaching materials for schools and presentations.

Food waste has not been extensively measured and reported on a national scale in Iceland before. This report contains the method and results for the first extensive measurement of food waste in Iceland for the reference year 2022 using a standardized EU methodology. The measurements were applied according to a strategy made by the University of Iceland and performed by Verkís Engineering. The Environmental Agency of Iceland managed the project. Food waste was measured for all stages of the value chain; primary production, processing and manufacturing, retail and distribution, restaurants and food services and households. Data collection methods applied were questionnaires, diaries and waste composition analysis.

The scope of the measurements was food waste produced in the year 2022. Liquid food waste discarded with/as wastewater was excluded. The research included both edible and non-edible food waste.

The results showed year that food waste in Iceland was 60.3 thousand tonnes in total for the reference year 2022. That equals 160 kg/inhabitant. Measured food waste was largest in the primary production step of the value chain; 29,130 ton or 48% of the total food waste in 2022. Second largest was food waste from households, which measured as 23,781 tonnes or 39% of the total. Restaurants and food services accounted for 6% of the total food waste (3.86 ton), retail and distribution for 3% (1.93 tonnes) and processing and manufacturing accounted for 3% of the food waste or 1.6 tonnes. The results provide a baseline for future studies and a foundation for setting goals and targets in food waste reduction.

[1] United Nations Environment Programme (2021). Food Waste Index Report 2021

1. Introduction

Food waste has received merited attention in Iceland since tackling the problem of food waste offers numerous social, environmental and economic benefits, including in the areas of reducing greenhouse gas emissions, resource use, food security, waste management, biodiversity and economic interests. Iceland has committed to reducing food waste in each part of the food chain by 30% in the year 2025 and by 50% in the year 2030, compared to the reference year 2022, which is in line with the UN's Sustainable Development Goal 12.3 of halving food waste by 2030.[2] Combatting food waste is also a designated part of Iceland's action plan against climate change, expected to bring about a reduction of 14 thousand tonnes of CO2 per year.[3]

The magnitude of food waste in Iceland has not been extensively studied but recent efforts have shed light on the scale of the problem. In 2016[4] and 2019,[5] the Environment Agency of Iceland set up studies in an attempt to measure food waste in the whole value chain. The studies were set up in two parts – food waste in households and in companies. Only the household part returned usable data in both cases. In the 2016 study, the measured food waste in households was 23 kg of edible food, 39 kg of inedible food, 22 kg of cooking oil and fat and 199 kg of liquids per inhabitant in that year. The 2019 study measured less food waste than in 2016, or 20 kg of edible food, 25 kg inedible food, 5 kg of cooking oil and fat and 90 kg of liquids per inhabitant in that year. The results suggested that the magnitude of food waste in Icelandic households was similar to the average EU household in both study years.

Another group of studies was carried out from 2015-2018 by the NGO Landvernd and master students at the University of Iceland.[6] The results of these studies support the estimate of the Environment Agency's studies but used somewhat different methodology so comparison between them is difficult.[7] However, according to the studies' estimates, food waste in households had been reduced between the years 2015 and 2018 from 49 kg to 27 kg, or by 44%, but that food waste levels in 2018 were similar to those in the Nordic countries.[8] All three studies

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[2] See page 30 in the policy *Í átt að hringrásarhagkerfi* („Towards a Circular Economy"): https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/UAR_stefnal_att_ad_hringrasarhagkerfi.pdf

[3] See Action F.3: https://www.stjornarradid.is/verkefni/umhverfi-og-natturuvernd/loftslagsmal/adgerdaaaetlun-i-loftslagsmalum/adgerdirnar/loftslagsskyrsla-stok/?itemid=74cf2e22-b195-11ea-8117-005056bc8c60

[4] The Environment Agency of Iceland (2016). Food Waste in Iceland – Methodological Report. November 2016, UST-2016:04. https://samangegnsoun.is/wp-content/uploads/2021/08/Food-Waste-in-Iceland-Methodological-report-with-Abstract-in-IS-28-11-2016-1.pdf

[5] The Environment Agency of Iceland (2020). Food Waste Statistincs for Iceland in 2019 – Final Methodological Report. UST2020:01. https://samangegnsoun.is/wp-content/uploads/2021/08/Matarsounarrannsokn-Umhverfisstofnunar-2019.pdf

[6] One of the studies was theoretical on the psychology of food waste. See: Sigurðardóttir, Sólrún (2017). Predicting Household Food Waste Reduction: An exploratory study comparing and contrasting the Theory of Planned Behavior and Value Belief Norm theory. Master Thesis. University of Iceland, Faculty of Psychology. http://hdl.handle.net/1946/26754

[7] These studies used the terminology „avoidable" food waste, which somewhat represents edible food waste.

[8] Burgherr, A. M. (2018). Food Waste in Reykjavik – a Comparison Between 2015 and 2018. Master Thesis. University of Iceland, Faculty of Life and Environmental Sciences. http://hdl.handle.net/1946/32307 and Burgherr, A. M., Sigurðardóttir, S., Magnúsdóttir, R. & Guðbrandsson, G. I. (2015). Forrannsókn á matarsóun reykvíska heimila. Landvernd. 93 pages.

used diaries as a data collection method, into which households registered data, which was then sent to researchers using an online platform.

Although previous studies signal that the extent of food waste in Icelandic households is similar to that of their European counterparts, almost nothing is conclusively known about food waste in other parts of the value chain of food. Obtaining data from previous parts of the value chain of food is especially relevant in Iceland, since the country is a sizeable primary producer and manufacturer of food, mostly seafood.

Reliable data on food waste are needed to determine whether Iceland is on track to meet its targets and, ultimately, whether objectives have been achieved. Data are also necessary to assess the outcomes of food waste reduction efforts and to evaluate the outcome of food waste related policy measures. Various efforts to reduce food waste have already been implemented in Iceland but their effect has been unclear due to lack of reliable data. These include, but are not limited to, websites about food waste, organized group action, activism and support for activism, seminars, food waste festivals, open educational courses, other educational projects and more.[9]

The Government of Iceland has implemented a distinct action plan on food waste, *Minni matarsóun*, in which the Environment Agency was tasked with providing regular measurements on food waste in the whole value chain of food using a methodology common to the European Union (EU). As part of the European Economic Area (EEA), Iceland follows member states' annual reporting obligation laid out in the Waste Framework Directive 2008/98/EC, which dictates the monitoring and uniform measurement of food waste in the whole value chain of food[10] on an annual basis, i.e. a full calendar year, using a common methodology. The details of the common methodology were laid out in the Commission Delegated Decision (EU) 2019/1597 supplementing Directive 2008/98/EC of the European Parliament and Council as regards a common methodology and minimal quality requirements for the uniform measurements of levels of food waste. The format of the report is to be found in Commission Implementing Decision (EU) 2019/2000 laying down a format for reporting of data on food waste and for submission of the quality check report in accordance with Directive 2008/98/EC of the European Parliament and the Council.[11]

In preparation for the measurement of food waste, the Social Science Research Institute of the University of Iceland was tasked with suggesting a research plan on how the EU common methodology could be implemented using what data were available in Iceland.[12] The Institute gave its recommendations to the Environment

[9] See a demonstrative list of actions in the Annex to *Minni matarsóun* (in Icelandic): https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Minni%20matars%C3%B3un%20-%20A%C3%B0ger%C3%B0a%C3%A1%C3%A6tlun%20gegn%20matars%C3%B3un.pdf

[10] The *value chain* and its stages are defined as in Commission Delegated Decision (EU) 2019/1597.

[11] The detailed guidelines for the reporting are available here: https://ec.europa.eu/eurostat/web/waste/methodology

[12] See Jónsdóttir, G. A., Gústafsdóttir, G. & Guðmundsdóttir, G. F. (2022). Mælingar á matarsóun 2022. Reykjavík, Háskóli Íslands, Félagsvísindastofnun.

Agency in April 2022 which subsequently hired Verkís Engineering firm to exercise the Institute's recommendations and perform measurements of food waste. Verkís handed in their results in July 2023 in the form of a memorandum, which has now been turned into a publication. In this report, the results of this first measurement of food waste in Iceland using the standardized EU methodology, covering the calendar year 2022, are presented and discussed.

2. Methods

2.1. Definition of concepts

Generally, concepts were defined as in Directive 2008/98/EC of the European Parliament and of the Council on waste and Commission Delegated Decision (EU) 2019/1597 as regards a common methodology and minimal quality requirements for the uniform measurement of levels of food waste, which supplements the Waste Framework Directive.

Food is defined as according to article 2 of Regulation (EC) 178/2002 of the European Parliament and of the Council laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. The definition of food waste, therefore, contains both the edible and inedible parts of food, but it does not contain animal feed, medical products, plants prior to harvesting nor animals prior to slaughtering, unless they are prepared to be placed on the marked alive for human consumption.

Food waste is defined as all food according to article 2 of Regulation (EC) 178/2002 of the European Parliament and of the Council, that has become waste, according to the definition og waste in Directive 2008/98/EC.

The **value chain** of food is defined as the moment from when a product becomes food according to definition until it is either consumed or becomes waste. For the purpose of convenience and standardization, the value chain is split into five stages, for which food waste was measured separately. These stages are:

1. Primary production
2. Processing and manufacturing
3. Retail and other distribution of food
4. Restaurants and food services
5. Households

Primary production is the first stage of the value chain and covers agriculture, forestry and fishing industries. Food waste from primary production mostly includes food waste from crops and animal production, hunting, fishing and aquaculture. Note that, according to the definition of food, waste from the primary production is not considered as food waste unless it occurs after the slaughtering of an animal, the harvest of a crop or, relevantly for the Icelandic setting, after the catching of fish.

Processing and manufacturing include any further operations in working the food from primary production. This includes cutting, trimming, sizing, storing and packaging food products or beverages. The distinction between primary production and processing and manufacturing can be blurry when it comes to on-vessel processing of seafood. As there is no clear distinction on when seafood transits from primary production to the processing and manufacturing stage, in this report any operations on vessels were considered as primary production, even if they include

trimming or freezing of seafood, while any operation in land were considered to be part of processing and manufacturing.

Retail and other distribution of food includes grocery stores, kiosks, fishmongers, specialty stores and wholesalers.

Restaurants and food services cover kitchen waste and plate waste from restaurants, but not food which is wasted outside the perimeter of the restaurants, such as take-away, which would rather be wasted in households or companies. Food services include catering companies and, at least theoretically, cafeterias, with the latter often operated under another ÍSAT/NACE category which makes them difficult to identify and contact. Accommodation services which sell- or provide food also fall under this category.

Households cover any food waste which occurs in households regardless of its origin.

Figure 1: Illustration of the value chain for food waste

2.2. Scope of the measurements

The measurements include food wasted in the calendar year 2022. During the measurement of food waste, the practicality of the measurements was emphasised without omitting any major streams of food waste.

The scope included the whole value chain of food but did not include major streams which are not typically used as food such as straw, faecal matter, animal by-products or other similar agricultural or forestry materials according to articles 2(1)(f) and 2(2)(b) from the Waste framework directive 2008/98/EC.

Note, however, that if the above-mentioned waste streams have entered the food chain, usually as more minor components, the measurements will include them, even if they are inedible, as long as they have become waste after they entered the food chain. So even if they are normally omitted from the measurements, the above examples could still be included in the measurements in the form of straw from shucked corn ears, the guts of wild fish catches which are cleaned in a household kitchen, the shells of cooked shellfish etc.

Substances destined for feed were not considered as waste.

Similarly, minor streams of food waste, intermixed with other waste streams, were omitted. These include, but are not limited to, food residues left within packaging waste and food residues from street cleaning. Non-food materials which are mixed together with food waste are omitted to the extent possible and practical.

Food waste drained as- or with wastewater were not covered in the study since their measurement is difficult to perform and synchronise between European member states. As a result, drinks, dairy products, some fats and oils, smoothies, soups and other foods typically wasted via the drain were either mostly, or completely, omitted from the study. Waste from food and beverage service activities, such as cafés and bars were also excluded from the study for this reason, since a large portion of their food waste was considered to be waste drained as or with wastewater. Therefore, it was assessed that including them in the study could result in erroneous results from this sector.

Despite fitting the definition of food waste, the illegal discard of fish from fishing vessels was not reported as food waste, even though official estimates of discards exist.[13] This was intentionally left out of the report in favour of uniform reporting, since other European states typically do not report this data in their own accounts. In some instances, the discard of fish, or parts of fish, from vessels is legal. In such cases, the discard was considered as food waste in this report. Catch-and-release fishing is omitted from the scope of this study, including the intentional release of viable individuals of red listed fish species, since these fish are considered not to have entered the food chain.

Some states report on data related to food waste prevention or other voluntary data related to further classification of the food wasted. These data can include the distinguishing between edible and inedible food waste, the amounts of food waste drained as or with wastewaters, the amount of food redistributed for human consumption, amount of former foodstuffs destined as feed, and more. None of these elements were reported on here.

2.3. Sample design, weighting and substitutions

Data collection was done according to methodology laid out in Annex III of Delegated Decision (EU) 2019/1597. The collection methods applied were questionnaires in primary production, processing and manufacturing and retail and distribution. In restaurants and food services a diary study was applied. In households, waste composition analysis was applied.

Industries

The sampling from industries, i.e. the first four stages of the value chain and not households, was done using a stratified semi-random sample from Statistics Iceland.

[13] Data on illegal discards are provided by the Directorate of Fisheries and the Marine and Freshwater Research Institute, see reports here https://www.hafogvatn.is/is/leit?q=brottkast

Metadata, such as address and ÍSAT 2008 categories (the Icelandic NACE categories)[14] were used to stratify sampling from the statistical population so that the sample would include different stages of the value chain, different company types or industries and different parts of the country. The samples did not include the companies' emails, so an email address had to be annotated manually using information available online.

The sampled companies received an email and a posted letter, both of which included background information about the study and a link to a questionnaire to be filled out online, and a phone call. The questionnaire included some key definitions of concepts, questions about the amount of food waste within the company in tonnes and as percentage of the produced final product. The questionnaire also asked about information on the main reasons for food waste within the company, waste composition and whether the company would be willing to participate in a follow-up questionnaire. The follow-up questionnaire included more detailed questions on the food waste within the companies, including their main drivers, composition, company policy, available data and numerous metadata questions which could potentially be used for scaling. The questionnaire for restaurants and food services differed somewhat from the questionnaire for the other stages of the food chain since it involved a diary study. Examples of the questionnaires are to be found in Annex I.

The scaling of responses was done by ÍSAT categories, so that responses from companies within each category were first extrapolated on the whole category, and then the categories were scaled for the whole stage of the value chain. For scaling, the focus was to use easy-to-obtain measurements. Results from primary production were scaled using production statistics in tonnes per year. The results from processing and manufacturing, retail and distribution and restaurants and food services were scaled using man-years. In some cases, no responses were obtained from any company in a given ÍSAT category. In that case, the average measured food waste in that particular stage of the value chain was used as substitute data for the empty category. When one or more companies from an ÍSAT category gave usable results, they were scaled to represent the whole category.

Households

For the household measurements, the waste composition analysis of SORPA bs., the waste manager of the municipalities of the Reykjavík Metropolitan area, was used. They create a biannual waste composition analysis of household waste under the name „Húsasorpsrannsókn SORPU" (SORPA household waste composition analysis). The analysis includes only waste from households but it indiscriminately includes both edible and inedible food waste so no attempt is made to distinguish between them. The analysis is presented as the amount of biowaste per inhabitant which was scaled using the average of the population of Iceland at the beginning of the year and at the end of the year, or 376,280 inhabitants.[15]

[14] See the complete list of ÍSAT categories here: https://www.hagstofa.is/utgafur/nanar-um-utgafu?id=54698

[15] Data on population in Iceland in the beginning/end of year 2022 gathered from Statistics Iceland https://px.hagstofa.is/pxis/pxweb/is/Ibuar/Ibuar__mannfjoldi__1_yfirlit__arsfjordungstolur/MAN10001.px/table/tableViewLayout2/

2.4. Sampling and non-sampling errors

Sample frame and coverage errors

As food wasted as- or with wastewater is omitted from the scope of the study, it was considered feasible to omit industries in which most of the food waste is expected to occur through these channels, since the voluntary reporting of data from these sector could risk the accidental reporting of majorly inaccurate data. These industries include the whole dairy sector, cafés and bars. Any food wasted in these industries, such as cheese from the dairy sector, pastries and sandwiches from cafés and snacks from bars were omitted, and therefore not reported in this study.

Hotels which operate restaurants are difficult to fit into the sample design since their operation is usually registered as the ÍSAT category for „accommodation" or related services. Some hotels also register as food services as a secondary ÍSAT category but even in those cases, there is no obvious way to make a distinction between which part of their operations is in accommodation and which is in food service. This sector was therefore especially difficult to collect data on, and the data obtained are also difficult to scale and interpret. While the results from the food services as a whole should be interpreted with some caution, the results from the hotel sector should perhaps be taken with additional relative caution.

An inconveniently common way of retailing in Iceland is with a „pay-by-sale" system. In this system, the wholesaler is responsible for filling the shelves of retail stores and when products expire, or are about to expire, the wholesaler takes back the products which are not sold. Pay-by-sale is common in Icelandic food retailing, especially in the retailing of fish, meat, fruit and vegetables. This system creates an ambiguous situation in which the wholesaler may regard their food waste as occurring during retail and that it should be reported by the wholesaler and not the retailer. On the other hand, the retailer may regard the wholesaler as being responsible and thus the retailer does not report the food waste. Although this problem was not addressed in the questionnaire, it is likely a factor contributing inaccuracy to the results.

A non-sampling error relates to cultural aspects of food and food perception. In Iceland, horse meat is traditionally eaten so any wasted horse meat is included in our measurements as food waste. Contrarily, egg laying hens and some small fish and fish parts, such as capelin heads, are not considered as food in this study, even though they may be included elsewhere.

Measurement errors

In the value chain of seafood, it was not always clear whether food waste occurred at the stage of primary production or during processing and manufacturing. As a typical example, on-board vessel fishing can be considered as primary production and after landing the fish, it has entered the processing and manufacturing stage. However, a common way of fishing in Iceland is the on-board processing of fish,

where it is caught, immediately cleaned and trimmed, frozen and even packaged on board the vessel. In such cases, it is neither clear where the primary production stage becomes the processing and manufacturing stage, nor is it practical to collect these data separately. For this reason, the on-board activities of fishing vessels were all considered as part of the primary production, while activities after landing were considered as part of the processing and manufacturing stage.

Data from the household waste composition analysis was scaled up for the whole country using data from the Reykjavík Municipal Area. Previous studies from the Environment Agency do not suggests that there is a difference in waste composition or quantity between households and the Reykjavík Metropolitan Area, so even though this is an indeterminate artefact of the sampling design, the bias is considered minimal.

Nonresponse errors

A more or less consistent uncertainty factor in our analysis is the lack of responses from the first four stages of the value chain. For the most part, we assign the lack of responses to the fact that the sampling size was relatively small, not all companies have data on food waste, or that they are not willing to collect and/or provide their data. In some cases, companies submitted some data but not enough to be of use in this study. However, to some extent, the lack of responses is due to the small size of the Icelandic economy. In some industries there are only a handful of companies available in the whole country so even if all of them participate, the sample size could still be small. The small economy also fosters a lack of will to participate in voluntary data provision because of the perceived risk of competitors being able to trace data back to the original companies. A minor cause of lack of responses was the inclusion of some defunct companies in the sample.

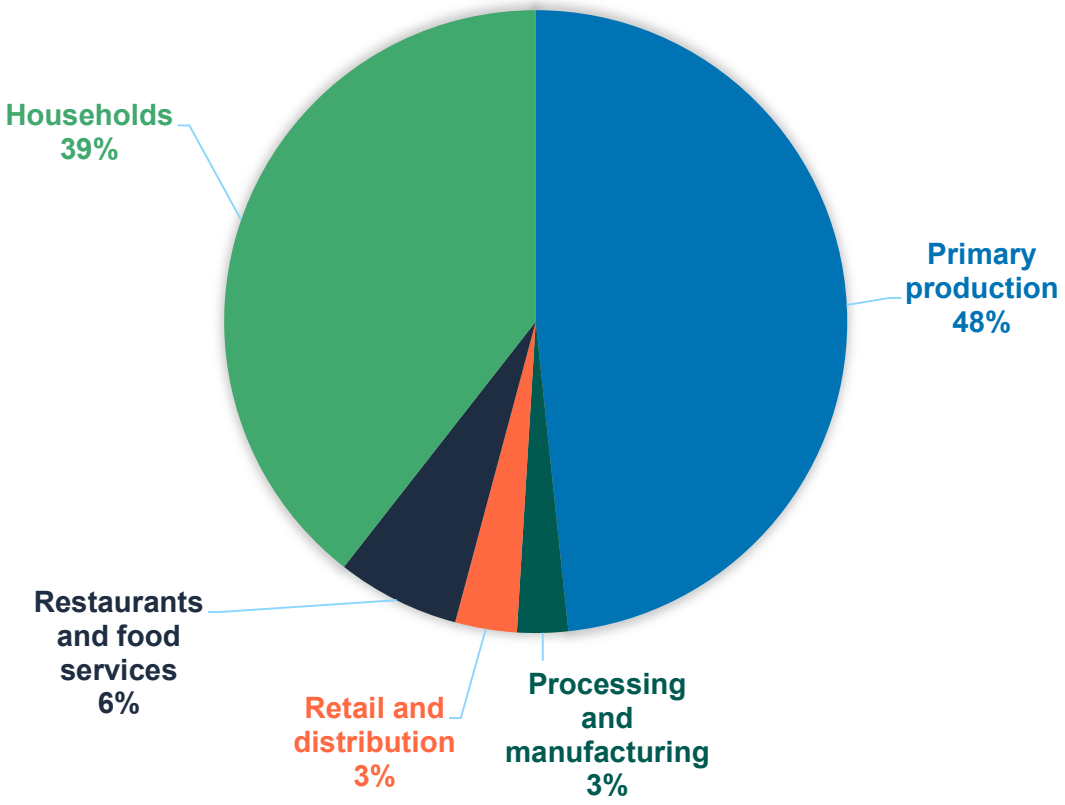
When no data was collected from a whole ÍSAT category, substitute data was inserted to avoid the use of false zeroes in the data. The substitute data was the average food waste in the relevant stage of the value chain. The categories for which substitute data was used are highlighted in the results section.

No data were obtained from the aquaculture sector, which is a big and emerging sector in Iceland. As no data were previously available either, and there was no obvious way to estimate the food waste in this sector, it was not considered possible to give any indication of the extent of food waste in aquaculture. Therefore, a false zero is reported from aquaculture.

3. Results

Food waste for the year 2022 was 60.3 thousand tonnes in total. That equals 160 kg/inhabitant. The primary production and household sectors have the highest generated food waste.

Following are the results for each stage in the value chain.



3.1. Primary production

The total food waste for primary production stage in the reference year 2022 was 29,130 tonnes. Results for primary production can be seen in Table 1. Starred numbers are estimated values based on food waste in similar categories within the primary production stage. Fish production has the highest amount of food waste for the primary production stage, or 86% of the total food waste for the primary production.

Category	Production quantity [t]	Food waste [t]
Fruits and vegetables	7,099	177
Potatoes	7,179	166*
Pork	6,369	22
Beef	4,948	445
Poultry	9,501	219*
Lamb- and sheep	8,659	87
Egg	3,950	198
Horse meat	951	22*
Fish (excluding illegal discards)	1,418,017	27,700**
Aquaculture	51,350	0*
Grains	9,400	94
Sum	**1,527,423**	**29,130**

*Table 1: Food waste in primary production in Iceland for the reference year 2022. * estimated numbers **excluding illegal discards*

3.2. Processing and manufacturing

The total food waste for processing and manufacturing in 2022 was 1596 tonnes. Further results for processing and manufacturing down to categories can be seen in

Table 2. Fish oil and fish meal has the largest measured food waste for this value chain stage, followed by processing and manufacturing of meat products and fish products.

Category	Food waste [t]
Bread, cakes and sweets	45
Meat products (excluding poultry)	336
Poultry	58
Grains	0.2
Candy and chocolate	48
Fish products, crab and molluscs	306
Ice cream	31
Dairy	98
Fish oil and fish meal	521
Fruits and vegetables	15
Other	138
Sum	**1596.2**

Table 2: Food waste in each category of the processing and manufacturing sector

3.3. Retail and distribution

Food waste for retail and distribution for the year 2022 was 1927 tonnes, further results for each category can be seen in Table 3.

Category	Food waste [t]
Wholesale with food and beverages	36
Wholesale with fruit and vegetables	238
Wholesale with fish and fish products	118
Wholesale with sugar, sweets and chocolate	2
Wholesale with other food	19
Fish shops	42
Grocery stores	1230
Kiosks	14
Other wholesale	130
Other retail with food	98
Sum	**1927**

Table 3: Food waste for each category within the retail and distribution sector

3.4. Restaurants and food services

The food waste for restaurants and food services in 2022 was 3856 tonnes. Results for each sector can be seen in Table 4. The largest amount of food waste was measured in hotels and guest houses with food services.

Category	Food waste [t]
Hotels and guest houses with food services	2780
Restaurants	824
Catering and other food services	252
Sum	**3856**

Table 4: Food waste in 2022 for each category in the restaurants and food services sector

3.5. Households

Data for households was retrieved from a waste composition analysis from Sorpa bs.[16] Total food waste from households was 63.2 kg/inhabitant. In total that is 23,781 tonnes, which accounted for 36% of the total food waste reported.

[16] Sorpa bs. (2022) Húsasorprannsókn. https://www.sorpa.is/frodleikur/husasorpsrannsokn-sorpu/

4. Discussion

Iceland has a goal for 30% reduction in food waste by 2025 and 50% reduction for 2030, compared the reference year 2022, in accordance with the United Nation's Sustainable Development Goal, Target 12.3. This research gives

The Icelandic policy: **Towards a circular economy** (Í átt að hringrásarhagkerfi) proposed that food waste should be the main focus for the years 2016-2017. The policy included information about current actions, measurement points and proposals for new actions. This measurement of food waste in the whole value chain was included in the current actions mentioned.

The research plan from the University of Iceland included guidelines for measurements for extent of food waste in Iceland, mapping of quality of data sources and proposal for method for selecting a baseline for food waste in the whole value chain. This work resulted in clear guidelines for the research ahead. This kind of preparation proved necessary since this was the first time that food waste has been measured to this extent in Iceland.

Verkís Engineering firm was hired to exercise the Institute's recommendations and **perform measurements of food waste**. The measurements were made in the form of questionnaires to households, businesses and public institutions in all stages of the value chain. Verkís handed in their results in July 2023 in the form of a memorandum. The measurements from Verkís resulted in low response rates, leading to lower data quality than expected. Some sectors had no data and then the data was projected from other similar sectors. Level of error was not calculated in this study. To gain higher response rate in future food waste measurement studies, it is recommended to send the questionnaires earlier in the year. It is recommended to take high-and low-seasons in companies into consideration, as the companies are more likely to have time for the measurements in low-seasons. Also, it is recommended to get the businesses on board with a voluntary agreement before measurements begin.

The preliminary results of this report have been presented on a few occassions, including in a keynote talk at the National Food Assembly (Matvælaþing) in 2023, on multiple occasions by the National Broadcasting Company RÚV and other media, and at a designated meeting with the minister of Environment, Energy and Climate.

Notes about the common methodology: Measurements include both edible and non-edible food waste. When comparing to results from other countries these factors should be taken into consideration. It is variable between countries what is considered as edible vs. non-edible food waste.

For the **household** measurements, the waste composition analysis of SORPA bs. was used. At first the plan was to use questionnaires with direct measurements from household as in the other value chain steps. Low answer rate resulted in very low data quality for the measurements. Thus, it was decided to use the detailed waste composition analysis that SORPA bs. publishes annually. Food waste from households has the most impact, as the food has been primarily produced,

processed in some way, transported, stored at the retailer and ends up discarded in households. The food waste has travelled the whole process chain with relevant energy and resource use along the way.

Restaurants and food services covers kitchen waste and plate waste from restaurants, but not food which is wasted outside the perimeter of the restaurants, such as take-away, which would rather be wasted in households or companies. Food services include catering companies and, at least theoretically, cafeterias, with the latter often operated under another ÍSAT/NACE category which makes them difficult to identify and contact. This makes them an error prone sector in our measurements. Accommodation services which sell- or provide food also fall under this category but they are also difficult to measure since there is not a clear distinction in their operative reports on which portion of their operations are food service related and which consist of accommodation. When this is unknown, the scaling and estimating of food waste in this sector is, at least partially, a matter of speculation.

Food waste from **retail and distribution** includes wholesales, supermarkets etc. As mentioned earlier, the reporting of food waste within the sale-to-sale system (is: skannasala) can lead to neither the wholesale nor the retailer claiming the food waste as theirs. Food waste should be taken into consideration within these systems.

Food waste from **processing and manufacturing** did not include liquid food waste discarded as or with wastewater. That excludes some major processing and manufacturing industries in Iceland such as the dairy industry for example. When comparing to results from other countries this should be taken into consideration.

The distinction between **primary production and processing and manufacturing** can be blurry when it comes to on-vessel processing of seafood. As there is no clear distinction on when seafood transits from primary production to the processing and manufacturing stage, in this report any operations on vessels were considered as primary production, even if they include trimming or freezing of seafood, while any operation in land were considered to be part of processing and manufacturing. Admittedly, this distinction is arbitrary and should be kept in mind when interpreting or comparing the data on primary production with those of the processing and manufacturing stage. This greatly influences the final results of this study and influences the perception of the reader when looking at graphs and data produced from this study. The food waste is porportionally largest in the primary production stage of all the stages in the value chain.

Annex I

Questionnaire on food waste for processing and manufacturing:

Matartap í vinnslu og framleiðslu matvæla

Könnun fyrir Umhverfisstofnun, unnin og framkvæmd af Verkís hf. um umfang matarsóunar á Íslandi. Athugið að ekki er hægt að rekja svör til einstakra fyrirtækja og munu upplýsingar um einstök fyrirtæki og þátttakendur ekki birtast í niðurstöðum rannsóknarinnar. Frekari upplýsingar um verkefnið má fá í gegnum netfangið [redacted] Nánari upplýsingar um matarsóun má finna á vefsíðunni Saman gegn sóun: https://matarsoun.is (https://matarsoun.is)

1. Er fyrirtækið þitt í rekstri og framleiðslu á matvælum eða afurðum sem notaðar eru í matvælavinnslu? *

- ◯ Já
- ◯ Nei

2. Nafn fyrirtækis.

Má sleppa. Nöfn fyrirtækja verða ekki birt í niðurstöðum rannsókna undir neinum kringumstæðum.

3. Hver er helsta framleiðsluafurð fyrirtækisins? *

Miða skal næstu svör við þá afurð sem valin er hér. Mögulegt er að svara könnunni oftar en einu sinni ef um fleiri afurðir er að ræða.

- ◯ Brauð, kökur eða sætabrauð
- ◯ Kjötafurðir, ekki alifugla
- ◯ Alifuglakjötafurðir
- ◯ Kornvara
- ◯ Súkkulaði eða sælgæti
- ◯ Fiskafurðir, krabbadýr eða lindýr
- ◯ Ís
- ◯ Mjólkurvörur
- ◯ Mjöl eða lýsi
- ◯ Kartöflur
- ◯ Other

4. Hversu mikið er framleitt af seljanlegri afurð á einu vinnsluári? *

Hér er beðið um gróft mat en möguleiki er að gefa nákvæmara svar í næstu spurningu ef upplýsingar liggja fyrir.

- ◯ 0,1 tonn eða minna
- ◯ 0,1 - 0,5 tonn
- ◯ 0,5 - 1 tonn
- ◯ 5 - 10 tonn
- ◯ 10 - 50 tonn
- ◯ 50 - 100 tonn
- ◯ 100 - 300 tonn
- ◯ 300 - 600 tonn
- ◯ meir en 600 tonn

5. Ef nánari upplýsingar um framleiðslumagn á vinnsluári liggja fyrir má skrá það hér í **tonnum**.

6. Hefur fyrirtækið markmið og/eða stefnu varðandi matarsóun? *

- ◯ Já
- ◯ Já, matarsóun er einnig mæld og ráðist er í aðgerðir til að draga úr sóun
- ◯ Nei
- ◯ Nei en matarsóun er mæld
- ◯ Veit ekki/vil ekki svara

7. Hve miklu magni af afurðum er hent (eða ekki nýtt) að meðaltali? Gróflega áætlað **hlutfall** (prósentur) af heildarafurð miðað við þyngd.

   Hér er undanskilinn úrgangur sem ekki telst sem matur, t.d. innyfli, bein, börkur eða hýði. Einnig er undanskilinn úrgangur sem notaður er til framleiðslu á dýrafóðri, bætiefnum eða lyfjum.

   Athugið að nóg er að svara annað hvort spurningu 7 eða 8 - en mögulegt er að svara svara báðum.

   Number must be between 1 ~ 99

8. Hve miklu magni af afurðum er hent (eða ekki nýtt) að meðaltali? Gróflega áætluð **þyngd í tonnum** af úrgangi.

   Hér er undanskilinn úrgangur sem ekki telst sem matur, t.d. innyfli, bein, börkur eða hýði. Einnig er undanskilinn úrgangur sem notaður er til framleiðslu á dýrafóðri, bætiefnum eða lyfjum.

   Athugið að nóg er að svara annað hvort spurningu 6 eða 7 - en mögulegt er að svara svara báðum.

9. Hve mörg stöðugildi tengjast framleiðslu fyrirtækisins?

   Má sleppa ef upplýsingar liggja ekki fyrir.

10. Hver er stærð vinnslurýmis fyrir framleiðslu fyrirtækisins (gróflega áætlað í fermetrum)?

    Má sleppa ef upplýsingar liggja ekki fyrir.

11. Hver er áætluð velta fyrirtækisins fyrir árið 2022 (í krónum)? *

    Má sleppa ef upplýsingar liggja ekki fyrir