UNEP Food Waste Index Report 2024 Appendix

1 Methodology for Level 1

A summary of the methodology used for the Level 1 estimates is presented in Chapter 1 of the *Food Waste Index Report* 2024. This appendix covers the methodology in more detail, in particular:

- How existing food waste studies and estimates were identified and obtained (section 1.1)
- How the data found from these studies was evaluated to inform its inclusion and our level of confidence in the estimate, including any adjustments made (section 1.2)
- The methods of calculation used to extrapolate data and create relevant estimates (section 1.3)

The methodology follows the same approach as taken in the *Food Waste Index Report 2021*. Much of this Appendix therefore repeats what was included in that report.

1.1 Literature Review

This section describes the process of finding relevant studies for this project. The first part describes the characteristics of the studies being sought, the second part describes the methods used for searching, the third describes the limitations.

1.1.1 Characteristics of studies included

This section describes the types of food-waste estimates that were sought as part of this study. In general, studies with comparable boundaries with the definitions of the Food Waste Index (FWI) were sought (although differences in definition were adjusted for where possible). In addition, the methodologies of studies included had to be of sufficient accuracy for tracking levels of food waste over time.

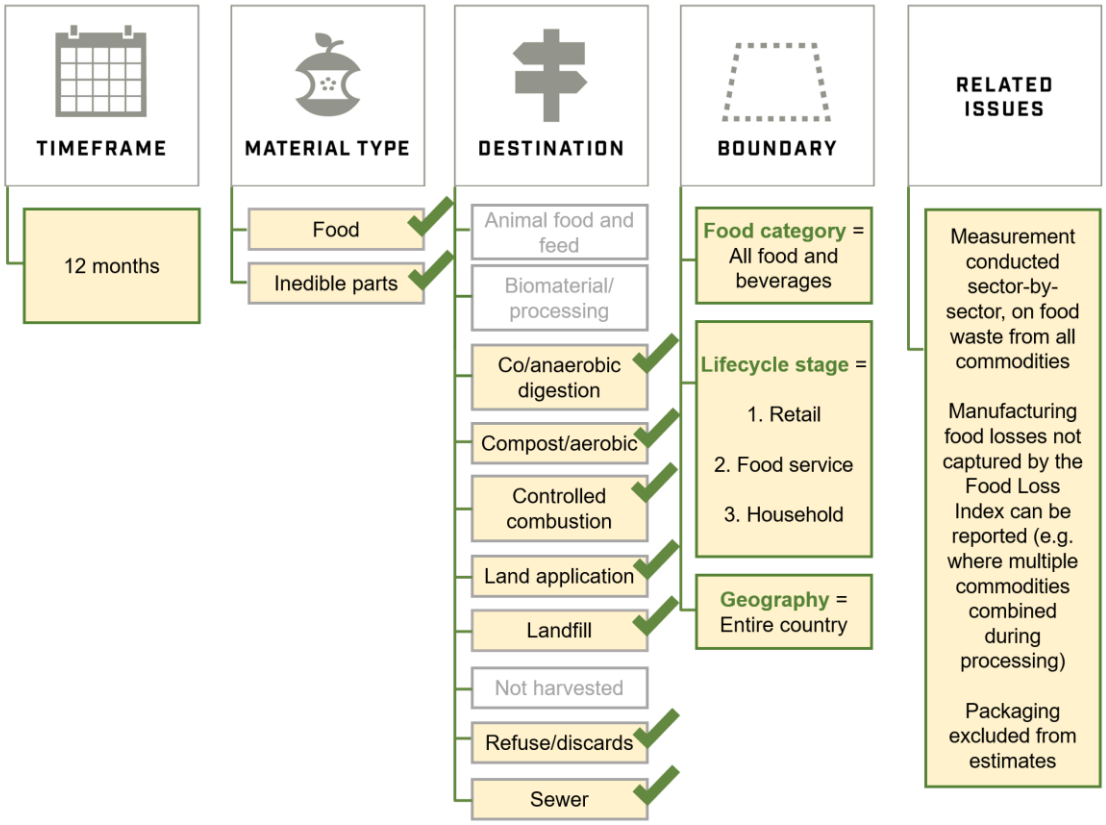

Figure 1: Scope of the Food Waste Index (Levels 2 and 3) adapted from the Food Loss and Waste Accounting and Reporting Standard (Hanson et al.*, 2016)*

Timeframe: When searching, we generally looked for papers which were published after 2005. In some limited cases, data from before 2005 was considered if there was nothing more recent identified for that country. Many countries which had studies pre-2010 have refined, repeated or updated those studies and latest figures were used in the current research.

Table 1: Distribution of datapoints by publication year

Publication year	Number of datapoints included
Up to 2005	1
Between 2006 and 2010	11
Between 2011 and 2015	35
Between 2016 and 2020	61
Between 2021 and 2023	139
Unclear or not published*	41

**Most of the studies with unclear year of publication are UN-Habitat 'Factsheet' studies, taken from the UN-Habitat map web portal, as the factsheets do not have publication years.*[1] *They do contain the year of the study, however, and in all cases the studies were conducted from 2019 onwards.*

Material type: Consistent with the FWI methodology, we searched for studies that quantified total food waste: both edible parts (sometimes referred to as 'avoidable' or 'wasted food') and inedible parts ('unavoidable food waste'). Studies did not need to separate these two parts from one

[1] https://unh.rwm.global/Map

another. However, where a study only included the edible parts, this was collated and – where possible – adjusted to account for the unquantified inedible parts (section 1.2.2.2)

Destinations: studies were sought that conformed to the destinations defined as food waste by the FWI: co/anaerobic digestion; compost / anaerobic digestion; land application; controlled combustion; sewer; litter / discards / refuse; or landfill. Studies were still collated if there were discrepancies between the destinations covered by the study and those covered by the FWI: where possible, adjustments were made (e.g., to remove food fed to animals from the estimate). This is discussed in section 1.2.2.5.

Sectors: Studies were sought covering any of the following: household, retail , and food service. In the case of food service, most studies reviewed did not make estimates for the entire sector. In general, we pursued papers which from the title and abstract covered a sufficiently large portion of the sector (i.e., restaurants, or canteens across a range of settings) but ignored those ones which had a very particular and narrow view (e.g., studies focused on university canteens only). Those papers which represented only a subsection of a larger sector have been collated into the appendix (section 2), as they may be useful for researchers and practitioners in those countries.

The definitions of sectors are outlined in Chapter 2 of the main FWI report according to International Standard Industrial Classification of all Economic Activities (ISIC). There are occasional differences between individual studies and these definitions. We applied judgement as to when a study's sectoral definition deviated too much from that our aim, with such studies being excluded. In many cases, insufficient information on sectoral coverage was provided to make this assessment.

A large number of studies present waste data based not on its source but its destination, i.e., collection by Municipal Solid Waste (MSW) services and disposed of in landfills, incineration and other waste destinations. Such studies were only included in situations where the MSW had been disaggregated by waste source to a sector comparable to the sectors being used here. For a fuller description of the approach to MSW papers, see section 1.2.4.1.

Geographic coverage: Studies were considered for inclusion regardless of whether their waste estimate was formed at a national or subnational level. This meant that subnational studies such as scoping studies for municipal waste plans, which were not focused on food waste estimation but did disaggregate waste to that level of detail, were considered. Studies at this level were particularly relevant for the household sector, which was often their focus. A distribution of datapoints by scope of study can be viewed in Table 2.

Often, the subnational estimate provided a per capita waste generation figure rather than a total waste generation figure. As many subnational estimates were urban in nature, this per capita waste may not be considered representative for the entire country. As a result, the confidence in estimates from these studies is reduced. This is discussed in section 1.2.3.1.

Table 2: Datapoints included, by geographical scope

	Household	Food Service	Retail
Nationwide	49	40	40
Municipality & Sub-national region	145	9	5

Methods and approaches: For this report, we were looking for studies which involve direct measurement of food waste or use data from other studies that involved direct measurement. This criterion is important as the purpose of the FWI is to track levels of food waste over time. This

purpose requires estimates to be reasonably accurate, collecting data from the relevant geographic area and time period and using a methodology without substantial bias.

Therefore, studies with the following methodologies were included: waste compositional analysis[2], direct weighing and scanning of wasted items. Unlike the *Food Waste Index report 2021*, in this report, household food waste diary studies were excluded. This is due to known issues with underreporting (Quested *et al.*, 2020) and inaccuracies introduced by the attempted adjustment of diaries to account for that underreporting, as it is likely to vary between places and studies. The much wider coverage of waste compositional analyses identified in this study meant that there were very few countries removed from the dataset by the exclusion of diaries.

For surveys, estimates for household food waste obtained directly from surveys (e.g., asking people to recall the amount of food waste generated) were not used. However, surveys of business representatives asking them to report their waste generation were included. These surveys, and data from industry more generally, were included due to the barrier to accessing commercial data. In very few studies presenting such data was it clear *how* it was generated, i.e., whether the businesses directly measured or estimated waste, and how robust measurements taken were. In the interest of ensuring there was sufficient data, a level of trust that self-reported business estimates were informed by measurement was therefore applied.

Table 3 presents datapoints by methodology. For a discussion of method and its relation to confidence levels, see 1.2.3.

Table 3: Breakdown of datapoints by methodology and sector

Method	Household	Food Service	Retail
Waste Composition Analysis	147	1	5
Literature	8	1	2
Mixed method	12	15	7
Surveys, questionnaires and interviews	0	2	1
Data from industry	0	2	3
Unclear, Governmental reporting	27	28	27

In the case of studies which combined waste generation factors with some other national statistic, the determining factor was the origin of these waste generation factors. In some cases, the waste generation factors were derived from direct observation in the relevant country (see for example, (Bontinck, Grant, and Lifecycles, 2021); in others, it is derived from a modelled estimate, typically using the FAO 2011 estimates (Gustavsson, Cederberg and Sonesson, 2011), often from data that is

[2] Otherwise referred to as a 'waste audit' or 'waste characterisation' study. All such studies have been coded as 'waste composition analysis' for simplicity.

old and / or from another country. The former would be accepted, and the latter would not for our purposes.

In a number of countries, there are existing publications which aggregate studies across multiple sectors for the purposes of estimating and reporting on food waste. These include national 'baseline' studies reported by national agencies, such as by the Environmental Protection Agency in the USA (US EPA, 2023). The data reported by EU-28 countries to Eurostat is treated in a similar manner. Where these studies were identified, they were taken as the authoritative source for the country and we did not prioritise further searches for those countries, nor the primary data sources on which the baseline was formed, unless some sectors were not covered by the publication. As a result, for some countries there are many more studies on food waste than presented in this database.

1.1.2 Search process

This review took a multi-pronged approach to sourcing data and estimates which differed in part from the approach in the *FWI2021* to build upon the lessons learnt in that process.

Data from the Food Waste Index 2021: As a starting point, all existing data was retained from the Food Waste Index 2021. These data were either replaced or added to depending on the nature of the studies identified. For example, ad-hoc academic studies in Europe were replaced by the more authoritative data reporting to the EU. However, in countries such as India where additional smaller subnational studies were identified, both older and newer data were included.

Online searches: Additional searches were conducted online. These were conducted using Web of Science, Google Scholar, and Google. Numerous searches were conducted using these engines, which combined search terms such as "food waste" and "quantification", "composition", "weight" and particular sector-specific terms. Learning from the experience of *FWI2021*, in which numerous useful datapoints were identified in the literature about household solid waste, specific searches for household waste compositional studies were conducted. Searches in French and Spanish were also conducted around similar keywords of 'food waste', 'kitchen waste', 'household solid waste' and so on. Searches were generally conducted for results from the year 2000 onwards, to include the possibility of identifying papers missed in *FWI2021*.

Papers were screened first on the basis of their title, then on the abstract/executive summary. Papers were sought that mentioned a specific geographic area (whether national or subnational, e.g., a city or a state), direct measurement of food waste, and specific sectors (household, food service, retail). If the title, excerpt and/or abstract mentioned some or all of these elements, it was downloaded and reviewed in more detail.

Over 1,280 papers were screened this way from academic searches, with hundreds of additional results from Google and Google Scholar considered. These searches returned very large numbers of results, many of which were not usable for our purposes, as they focused on topics such as chemical composition, behavioural determinants of (self-reported) food waste or perceptions of food waste. These papers are important for designing policy to reduce food waste and deliver SDG 12.3. They were not, however, relevant for our purposes and so were screened out.

In July 2023, after the initial period of review, codifying and building the database, some country-specific searches were conducted. These focussed on specific countries for which data had not been identified, including Iceland, Kazakhstan, and Libya.

For **grey literature**, searches were conducted primarily on Google. Through this, some particular organisations with useful resources were identified, such as the Japanese International Cooperation

Agency (JICA, highly cited in the *FWI2021*), UN Economic and Social Commission for Asia and the Pacific (UNESCAP) and the South Pacific Regional Environment Programme (SPREP). These sites were then searched more thoroughly for other possibly usable resources.

Data reporting: In the *FWI2024,* two additional data reporting exercises were integrated. Firstly, UNEP ran a pilot in early 2023 with ten countries on reporting data for SDG indicator 12.3.1(b). The responses to this exercise were integrated where they met the necessary criteria. Most countries were not able to report suitable data for most sectors. Where the country responses included reference to existing publications (the US and Argentina), these were included in the analysis with reference to those documents. Japan sent time series data without a single available report capturing all of this information, so their data reporting is referenced directly. In addition, the first year of the EU-28's reporting was made available via Eurostat. At the time of writing, insufficient methodological metadata was provided to robustly evaluate each estimate ourselves. The estimates identified this way are therefore reported as a separate confidence classification, "EC" for European Commission. This is discussed in the main report.

1.1.3 Limitations with the search method

No search will be 100% effective. This wide-ranging searching strategy was designed to obtain the maximum number of relevant studies within the constraints of the project.

Resource and time constraints meant it was not feasible to evaluate every single page of search results from the Google and Google Scholar searches, given both the large number of results and large number which were not relevant for our purposes here. It is possible that some studies exist which were not found, particularly in 'grey' literature reports which are less easily identified.

Although studies from a wide range of countries in a range of languages were obtained, there remains the possibility of geographic bias. The sharing of missed information by researchers in those regions would be helpful to redress this.

1.2 Data Extraction and Adjustment

This section contains details on:

- The information recorded from each study (1.2.1)
- Adjustments made to data to increase comparability (1.2.2)
- Classification of estimates based on our confidence in the estimates (1.2.3)
- Decisions relating to whether studies were included in the calculations (1.2.4)

1.2.1 Data Extraction

For each relevant study identified, the core information searched for and extracted (beyond bibliographic information) was as follows:

- Geographic boundaries
- Time of study
- Sectors covered
- Methodological details, including sample size, length of sampling and representativeness
- A share estimate (e.g., x% of household solid waste was food waste, or y% of total national food waste occurs in a particular sector).
- A total mass estimate for that sector and geography
- A normalised (per capita) mass estimate for that sector and geography
- The share of food waste which was considered edible or avoidable

- The share of total waste which was other ‘organic’ wastes
- The waste destinations, particularly if included in the paper estimate was some waste which goes to an avenue not considered waste in the FWI

Very few studies had all of the above information: in some cases, it was not relevant to the scope of the study; in others the information was not reported in the publication. As much of the above list as possible was captured.

All total and normalised mass estimates were input using the measurement scale used in the paper (e.g., million tonnes / year, g / capita / day) and then adjusted for this study to a single comparable figure for total mass (tonnes / year) and normalised mass (kg / capita / year).

In some cases, the original mass value was presented as multiple numbers (such as edible and inedible waste separately) or required some calculation (such as where daily total waste generation is presented alongside a percentage which was food waste, allowing daily food waste to be derived). These calculations were carried out to ensure comparable figures. As much as is possible, these calculations are kept in the relevant cell in the downloadable Excel file so that readers can see the calculations and trace back to the numbers in the source publication.

We searched within papers for estimates of ‘food waste’, sometimes referred to as ‘kitchen waste’. Definitional consistency was an issue in several papers: many studies used the terms ‘kitchen waste’, ‘organic waste’ and ‘food waste’ interchangeably within the same paper. In some cases, the term ‘organic’ would be used but only foodstuffs listed in the table describing the categories, on other occasions the term ‘organic’ would be used in a table or graph with ‘food’ being used to label the same category elsewhere in the paper.

To deal with these problems, we used the definitions applied by the authors. If they labelled a category as food or kitchen waste (without further elaboration on the definition), this was understood to mean edible and inedible food waste. In addition, most authors defined garden/yard waste as a separate category. This presents the most notable bulky organic waste stream outside of food, so its inclusion as a separate category increased confidence that what was labelled as ‘food’ was, indeed, food waste. However, if they only used the term ‘organic waste’ without referring to it as ‘food waste’ elsewhere, or indeed were explicit that the category included non-food wastes, then these were excluded.

It remains possible that other, non-food wastes have been included in some of the categories: animal excrement for example varies whether it is included or not, and it is often unclear what category they have fallen into (‘organic’, ‘general’, ‘other’ etc.). This is a limitation of the estimate which unfortunately could not be avoided: we have tried to work as best we can with the data available from the papers. For a discussion of the organic waste studies which were excluded, see section 1.2.4.2.

1.2.2 Data adjustments

There are a number of different ways in which food waste can be measured and reported. This presented a challenge as we were aiming to produce results which are as comparable across estimates. In order to make the data as comparable as possible, a number of adjustments were carried out to specific datapoints to account for time difference, measurement boundaries or measurement bias. These are outlined below. Some of these adjustments add extra uncertainty to estimates, reducing our confidence.

1.2.2.1 Population statistics

In order to create a single comparable food waste baseline, all estimates were normalised to a single year: 2022. To do this, we assumed that per capita food waste has held constant since the time of the estimates identified. This enabled us to use 2022 population statistics for the purposes of scaling per capita waste estimates to country-wide estimates and global food waste extrapolations. All data on population and other relevant national indicators was downloaded from data.un.org on 04/07/2023.

Some of the identified studies did not present waste as a *per capita* estimate, but rather *total mass* for a specific sector and location. To enable scaling, these estimates were normalised to a per capita estimate. For national estimates, the same UN data source was used. As this data source does not provide a continuous time series, a linear interpolation was made between available data points to infer the population of intermediate years. This allowed an estimate of population in the year of each study to be used to normalise the total mass estimate. Once expressed as a per capita waste estimate, it was possible to scale these by 2022 population figures to form a country estimate.

A worked example to make this clearer: the figures reported by Japan as part of the UNEP data pilot were in total tonnes wasted per year: for households, 7,475,000 tonnes in 2020. From the UN population data, Japan had about 125.24 million people in 2020. With these two figures, a per capita estimate of 60 kg/capita/year can be derived. This is then applied to 2022 population figures for the purposes of scaling the estimate.

In the case of subnational studies presenting total mass rather than per capita, the population as listed in that study or paper was used to ensure consistency in the boundaries used to define the area. If the study did not present a population for that area, population figures for the area were taken from other online sources for a relevant year.

Some studies did not provide information as to the year the observation took place, or what year the waste estimate refers to. In these cases, the year of observation was assumed to be two years prior to the year of publication.

1.2.2.2 Edible share adjustment

Food can be divided into the share which is edible by humans (such as the flesh of a fruit or animal meat) and that which is generally considered inedible (such as onion skins, banana peels and animal bones). Due to the inedible fraction, a world without some degree of food waste is unlikely: eating a banana often leads to wasting its skin. A reduction in the edible share will have a knock-on effect on the amount of inedible waste (fewer bananas wasted may mean fewer bananas are grown to meet the same demand, which may lead to fewer skins wasted in total). As a result, general policies and interventions which target food waste are usually targeting the edible share. Many studies therefore focus their analysis on the edible fraction of food waste as this is the portion which is directly targeted by food waste reduction campaigns.

The definition of food waste used for the purposes of SDG 12.3 encompass both the edible and inedible fractions of waste. In order to compare studies which only record the edible waste with those which record edible and inedible parts, the omission of the inedible fraction required adjusting. Many studies report *both* the edible and inedible waste (or the similar distinction between 'avoidable' and 'unavoidable' waste). These were taken to mean the same thing: whilst there are subtle differences between 'avoidable' and 'edible', they were considered sufficiently comparable.[3]

[3] (For a discussion of these definitions, see Section 2.1.2 of: WRAP, 2018)

In the cases where 'possibly avoidable' was measured, this was divided into two and allocated evenly between 'avoidable' (edible) and 'unavoidable' (inedible).[4] The share of waste which was edible or avoidable was then converted into a percentage share. From here, it was possible to create sector-specific scaling figures through the following calculation:

$$Sector\ edible\ scaling\ factor = \frac{1}{Reference\ edible\ share}$$

For **household, t**he approach to edible and inedible adjustment was improved from the *Food Waste Index report 2021*. Where that report used a single edible scaling factor, this report used bespoke factors for each paper which required it. There were four papers included which stated only had 'edible' food waste estimates which required adjustment, these sources and the reference edible share are summarised in Table 4.

Table 4: Household edible adjustments

Source	Country	Reference edible share	Reference source
(Xue et al. 2021)	China	34%	Average of UMC estimates (from Indonesia and Brazil)
(Elimelech, Ert, and Ayalon 2019)	Israel	54%	From a different study in Israel (Elimelech, Ayalon and Ert, 2018)
(Singapore National Environment Agency 2017)	Singapore	57%	Average of HIC estimates (Israel, Japan, New Zealand, Switzerland, UK)
(Eurostat 2023)	Spain	49%	Average of European estimates included in FWI2021

For **Food service**, the adjustment was required in two studies, from China (Xue *et al.*, 2021) and Iraq (Filimonau *et al.*, 2023). For this, the average edible share from all included food service studies (69.3%) was taken.

No **retail** studies were included which required adjustment.

1.2.2.3 Aggregating socioeconomic groups

In some papers, particularly those looking at household solid waste in a smaller urban region or city, households were grouped into multiple socioeconomic groups (mostly high, medium and low) and sampled based on their socioeconomic status. As a result, the study would generate multiple shares of food waste in the residual waste and multiple daily waste generation factors. In some cases, the studies aggregated this information themselves based on the relative population shares of those socioeconomic groups, but in some cases did not.

Where multiple estimates needed aggregating for the purposes of providing a single per capita datapoint, the estimates for each socioeconomic group were weighted based on that socioeconomic group's share of the total sample. It was therefore assumed that the sampling attempted to mirror the wider population; in many cases, this was explicitly described as the intention but in other cases it was not mentioned at all. Therefore, there is a risk that some datapoints have been aggregated in a way which does not reflect the distribution of socioeconomic groups in the country or territory in

[4] The assumption behind this decision was based on the analysis in (WRAP, 2018)

question. This is a limitation but not one easily avoided: typically, studies in sub-national areas used *ad hoc,* relative definitions of the socioeconomic groups based on variables such as income, predominant housing type in an area, classification of a neighbourhood etc. As a result, finding comparable data which could have been used to weight these estimates more accurately was not viable, and the share of sample size was taken to be approximate to share of population.

In some cases, exact sample sizes of the different socioeconomic groupings was not provided. In these cases, the weighted average (mean) of the socioeconomic groups was taken.

1.2.2.4 Aggregating study periods

In some cases, studies were carried out in multiple time periods to estimate seasonal variations, such as between rainy or dry seasons. In cases where this was averaged by the author to create a yearly average, this value was taken. In cases where the author did not average the seasonal variation but instead presented them as multiple tables or datapoints, a simple mean average was taken of these generation figures. Whilst this would not be quite as accurate as weighted averages which account for season lengths, it was not considered to make a substantial difference and in many cases food waste was quite consistent, whereas some other wastes (such as garden) saw substantial variation. In many cases, studies were conducted during a single week or time period.

1.2.2.5 Removing non-waste destinations

For a small number of studies, other adjustments were possible based on information regarding disposal routes:

Food waste destined for **animal feed** is not considered waste as part of the FWI. A small number of studies had estimates of the destinations for waste including that share which was going to animal feed. In some cases, the authors had already removed this from the estimate which was reported as waste. In other cases, the share going to animal feed was used to adjust the waste estimate used in the present study. Similarly, food which is **donated** to charitable organisations for human consumption is not considered waste and was removed where the authors had not already done so.

Food waste disposed via the sewer was removed in the *Food Waste Index 2021* but has been kept, where known, in this report. Where known to be included, that has been mentioned in the description of that datapoint, as this may hinder accurate comparisons between different datapoints with different scopes. Sewer waste is included under the FWI definition and is included under Level 3 reporting (see Section 3.4 of the main FWI report).

1.2.3 Data classification

All datapoints which fit the above criteria were considered for the purposes of extrapolating estimates of food waste. However, the studies varied in their methodologies. These factors impact our relative confidence in the robustness and accuracy of each datapoint and, therefore, each estimate for a specific country.

To reflect our confidence in the datapoints, studies were grouped into two 'tiers' which correspond to whether the estimate for a country is *High* or *Medium* confidence (for countries without identified estimates and therefore requiring extrapolation, confidence levels are either *Low* or *Very Low*). These correspond to methodological detail: datapoints in which we have higher confidence involved more accurate quantification, estimated waste for the entire country and had a sufficient, representative sample size. The datapoints in which we have *Medium confidence* correspond to some studies which required adjustment, namely studies focusing on a specific sub-national area, or only measuring edible waste. Similarly, referenced figures which were unfindable, had unclear methodology or small sample sizes were typically classed as *Medium confidence,* even when

reported by an authoritative body such as a government department. Where a *High confidence* paper was available for a specific country and sector, this was used and any *Medium* confidence papers for the same country and sector were excluded from further analysis. In addition, all data reported to the European Commission was given a separate confidence classification, denoted *EC*. Though the European Commission's methodological guidance is broadly aligned with the Food waste Index, other than the potential inclusion of wholesale in retail estimates (discussed in the main report), information was not available at the time of writing on the specific methods for most of the specific datapoints, so how well this guidance has been followed by Member States was not clear. A full description of the boundaries between confidence levels for each sector follows.

It should be noted that confidence ratings are an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country, not a judgement on the quality of the study undertaken. In many cases, food waste measurement was *not* an aim of the original study. Hence many good studies will be classified at a *Medium* confidence level (or even excluded from consideration altogether) as the aims of the paper did not include national food waste tracking. Some of these studies would be suitable for tracking at a sub-national or municipal level.

To see the full list of included datapoints and their confidence level, see Section **Error! Reference source not found.**.

1.2.3.1 Sub-national studies

A number of studies, particularly in the household sector, measured food waste in part of a country (e.g., a state, province or city). These sub-national studies include those with a mixture of urban and rural (e.g. one study in China divides the country into broad geographical regions such as 'East China' (Zhang *et al.*, 2020)) and studies exclusively in an urban area (such as Beirut, Lebanon (Chalak *et al.*, 2019)). In these cases, applying the per capita waste figures for each sector to the population of the whole country would assume comparability between regions and that rural and urban waste generation are comparable, assumptions which are likely to be inaccurate. Very few studies focused on rural waste, meaning it was not possible to form an estimate of the variation between urban and rural waste (for one example of a study including both rural and urban households, see JICA (2015) in Gujranwala, Pakistan). Differences between urban and rural waste generation from the few datapoints identified are discussed in the main report.

As a result, all studies which were at a sub-national level were classified as *Medium confidence* with regard to an estimate of *national* waste, regardless of whether they met the methodological criteria for each sector (discussed in following sections) Where a sub-national estimate was identified alongside a national estimate for the same sector, the national estimate was prioritized unless there was some methodological reason to exclude it.

All studies are, to some degree, local in their sampling. When a study was in a specific locality but the authors described this as being representative of the wider country and the authors weighted their results by national distributions (of income, household size or type etc.), this was considered a 'Nationwide' rather than 'Sub-national' study, and therefore could be considered a *High confidence* estimate.

1.2.3.2 Household

For the household sector, we have assigned higher confidence in studies which involve the direct weighing and measurement of food waste by an external researcher. This includes waste

compositional analyses, direct weighing of food-only waste streams and papers which combine waste compositional analysis with other data for scaling purposes.

Within studies which directly weighed waste, sample size was used as a further determinant of our confidence in the estimate. The figure of 700 household 'waste-days' (households sampled per day * number of days sampled) was used as a cut-off point. Above this, nationwide studies were considered *High confidence*, all papers under this were *Medium confidence*. In some papers, the duration of sampling was not specified (see Grover & Singh (2014) in Dehradun, India, for example). This ambiguity meant it was considered prudent to provisionally classify these as *Medium confidence* unless more information were to become available. Choosing a boundary to classify studies is an imperfect science and there is not a single answer as to whether a larger, more time limited or smaller, longer sample is preferable for estimating food waste. The 700 waste-day figure was chosen because it equates to 100 households sampled for a week-long period, which was a common sampling approach. The methodology encouraged for countries conducting baseline studies and reporting this includes a minimum sample of 400 households, and is discussed in Chapter 2 of the main report.

Other methodologies required adjustment to be comparable, namely those which measured only edible food waste (see 1.2.2.2). As a result of the uncertainty stemming from these adjustments, the final waste estimates we use were considered *Medium confidence*.

Additionally, a number of papers referred to statistics or figures without presenting methodological detail or from sources which we were unable to trace further than the secondary reference. In many cases this was due to unclear referencing or citing papers which could not be found based on online searches. If unfindable, but referenced in a publication which was peer reviewed, by a reputable organisation or governmental publication, or a reference of a governmental publication which could not be found, these datapoints were included. These papers were classified as *Medium confidence* based on the uncertainty stemming from being unable to view the primary material.

1.2.3.3 Food service

The food service sector is a notably problematic sector for the generation of High confidence estimates of the entire sector. Many studies provide a robust measurement of a single establishment or subsector of establishments (such as hotels, or university canteens) but adequate collation and scaling of a range of subsectors is needed to form a nationwide estimate. As a result, the overall level of confidence is lower than in the household estimates.

We judged ourselves to have High confidence in waste audit studies which met two criteria:

- Sufficient sample size, auditing waste in at least twenty establishments
- Coverage of establishments in both the commercial (such as hotels and restaurants) and non-commercial sector (such as schools and hospitals)

As a result, no countries for which new estimates were identified were classed as *High confidence*. Some *Medium confidence* estimates are included which are known to represent only one subsector, such as restaurants. Where perceived to be a significant subsector, or estimated to have significant food waste, these have been included, but should be understood as a minimum for the country, as coverage of more subsectors will only increase the overall waste estimated.

Many authors identified that chefs and managers were resistant or openly hostile to the prospect of independent waste audits. In addition, some commercial bodies (particularly larger restaurant chains or catering providers) may already measure their waste. As a result, surveys of businesses or

chefs are often employed. Surveys of chefs with over 100 respondents or carried out by an authoritative trade or governmental body, and covering both commercial and non-commercial, would also be considered High confidence. It should be noted that there is insufficient detail in papers to say with confidence that waste was directly measured by food service organisations prior to responding to surveys, or indeed to submitting their data to governmental auditors. Given the commercial imperative to measure waste, but also the difficulty in initiating researcher-led audits, this uncertainty was considered acceptable.

Estimates in which we only have Medium confidence relate to those which had any of the following limitations:

- Only measured edible waste and therefore required adjustment
- Were referenced in secondary peer reviewed or governmental publications but with an original source we were unable to trace or access
- Cover food service establishments in either commercial or non-commercial sectors only

The inclusion of this third category of paper, which represents an 'incomplete food service' estimate, means there is a downward bias to the results leading to substantial underestimation and that actual waste across the food service sector is likely to be significantly higher

The food service estimates have big limitations for three reasons:

Firstly, looking at waste in per capita terms may not be the most suitable metric for this sector. Some countries may have more restaurants or catering than others based on particular economic and cultural conditions, and it is likely that there is some balancing between household waste and food service waste (i.e. based on what share of meals are consumed in or out of the home). Countries with large tourist economies will be expected to have more restaurants and hotels relative to population, and therefore likely more waste.

Secondly, the sheer breadth of the out of home environments in which food waste could be generated creates problems for quantification. As covered in Chapter 2 of the main report, it is recommended that a minimum of three subsectors are considered for national measurements, whilst acknowledging that countries are unlikely to be able to measure absolutely all subsectors. This leads to an inconsistency in scopes in the reported figures, so they are not all suitable for comparisons with one another. Balancing an accurate estimate of out of home waste with the limitations of practicality and resources remains a challenge.

Thirdly, food waste going down the sewer is inconsistently measured. In some settings, such as coffee shops or bars, this could be considerable.

1.2.3.4 Retail

Retail, like food service, has the problem of being considered commercially sensitive data, making it more difficult for researchers to carry out audits or access existing records which may be carried out internally. Whilst some supermarkets are publishing their data, a sufficient number of supermarkets in any given country needs to do so for this to give insight into national waste.

The inconsistency with which sample information was provided meant that it could not be used to form an assessment of confidence in the estimate. Instead, differences in methodology were grouped. The High confidence estimates refer to those in which a waste audit was carried out by or with the assistance of external researchers, whether weighing or using supermarket scanning systems, and those estimates which involved the disclosure of internally collated supermarket data

to a relevant body, whether governmental surveys (as in Japan), industry agreements (as in the UK) or other forms of public disclosure.

As with food service, there is an issue of scope and which subsectors are included or not. The relevance of different subsectors, particularly the extent to which supermarket retail can be considered representative of the whole retail sector, will depend on national/regional circumstances. In some places, farmers' markets and other traditional markets play a big role in food supply. Similarly, specialist retail like bakers' or butchers' shops will play a significant role in some countries. Some estimates have been included which only cover markets where they are believed to be significant (e.g. in Brazil, (Brancoli *et al.*, 2022)); in these cases, the lack of supermarket estimates means they are very likely to be substantial underestimates and should be understand as a minimum for retail food waste.

The estimates which were judged Medium confidence included studies with less transparency or potentially less robust data, including any of the following limitations:

- Interviews with supermarket representatives where it is unclear whether the estimates provided came from direct measurement within the retail establishment
- Estimates referenced in secondary peer reviewed or governmental publications but with an original source we were unable to trace or access
- Estimates which only cover part of the retail sector (e.g. only supermarkets, or only markets) where other channels are expected to play a significant role (>c.25% market share)
- Estimates which only measured edible waste and therefore required adjustment.

1.2.4 Rejected estimates

Below is a brief description of the two primary categories of papers which were narrowly rejected but could be applicable in other scenarios for forming very rough, 'order of magnitude' estimates of food waste.

1.2.4.1 MSW papers

There are many papers which document waste compositional analyses which we were unfortunately unable to consider here due to the sectoral uncertainty around them. Papers which analysed the MSW of a geographical area often disaggregate food from other organic and biological waste, however, the uncertainty of the origin source of the waste means it could not be said with any certainty what was being measured.

MSW will typically be dominated by household waste, but other wastes from litter bins on the streets, commercial waste from small businesses including restaurants, retailers and street vendors may make their way into the MSW. Furthermore, not all households or businesses will necessarily have access to MSW collection rounds: their waste may be processed through informal or illegal routes. As a result, papers which analyse MSW without disaggregating the source are difficult to use in the current study. This includes information about waste samples from landfills or waste transfer stations, other than in situations where samples are only taken from waste collection vehicles which are known to have been completing a household/residential collection.

There were a few MSW-based papers that provided usable estimates. These were typically when a *residential* solid waste specific estimate was provided (i.e., disaggregation of the total MSW estimates). To provide an example: Denafas et al. (2014)'s waste compositional analyses in four East European cities had three MSW estimates which were unusable and one residential solid waste which was usable. For Kaunas, St Petersburg and Boryspil, the methodology describes taking a waste sample from a transfer station or landfill. This sectoral uncertainty means it could not be used. By

contrast, the sample taken for Kutaisi in the same study was specifically a sample from residential areas. By virtue of being residential only, it can be used as an estimate for household. This example demonstrates how the specificities of method and where the sample was taken could be the difference between inclusion and exclusion.

Some MSW papers claimed to be looking at the household share of MSW, without clarifying how exactly that was determined (see (Xue *et al.*, 2021),for example). In these cases, the claims of the researchers have been trusted and they have been codified as household estimates, although the uncertainty means they are classified as *Medium confidence*.

By not including MSW papers, we are not able to use the insights provided by another big source of waste data: the World Bank's 'What a Waste' dataset (Silpa Kaza *et al.*, 2018). This was searched within for possibly relevant papers, but for the reasons described in this section, the data could not be used directly.

1.2.4.2 Organic estimates

There were several papers, particularly in the household sector, which evaluated only the total organic rather than food waste. The organic fraction could contain a wide range of materials, including food, garden (green) waste, wood and leather. The relative fractions of these materials within the total organics will depend on a range of factors, most notably around garden waste, including: presence of gardens, feeding of domestic animals, climate (affecting the amount of growth) and whether the geographical area in question provides collection of garden waste (e.g., for industrial composting or anaerobic digestion).

For studies where there was no disaggregation of total, we considered the possibility of calculating the approximate amount of food waste from the total organics. This could be achieved by taking the average percentage of food waste within total organics from studies that did provide this information and applying this average to those studies that only provided total organics.

Two problems arose in applying this method when tested in the *Food Waste Index 2021*:

- The average percentage of food waste in total organics varied widely between studies: the lowest value was 24%; the highest 98%. (Mean = 81%; standard deviation 17%). This wide variation likely reflects the factors affecting garden waste mentioned above and makes applying an average value to obtain even an approximate estimate of food waste in a county with an organic-only estimate problematic.
- In some cases, the extent of garden waste varied substantially based on the income grouping of the households, with some high-income households having substantial garden waste (equal to or exceeding food waste) and low-income households having no garden waste, likely due to not having gardens. Greater variation was observed between income groups than for food waste, making it more difficult to make generalisations applicable to other countries/settings.

Furthermore – and as mentioned in section 1.2.1 – terminology used around these concepts is not standardised. Some studies use the terms 'kitchen waste', 'organic waste' and 'food waste' interchangeably within the same paper.

For these reasons, we deemed that estimates obtained in this way (i.e., applying the average percentage of organics waste which is food to studies with a total 'organics' category) insufficiently accurate. We believed that it would be slightly more accurate to extrapolate from similar countries than to use these calculations.

1.2.4.3 Surveys

Household surveys in which a representative of a household is tasked with recalling the waste they or their household has generated over a period of time were considered too inaccurate and incomparable with the other measurement methods considered here. As a result, no studies which *only* distributed a survey to households were included. (Many studies distribute a survey alongside a waste compositional analysis, for the purposes of collecting demographic information.)[5]

By contrast, surveys of organisations such as manufacturers, managers of retail organisations or restaurant chefs were considered sufficient for inclusion. Whilst they still have problems typically tied to underestimation, the commercially sensitive nature of the information makes direct external observation more difficult. The commercial incentive to reduce waste means many companies may have internal procedures which would inform survey responses, making them more accurate than household estimation via surveys. However, the quality of opaque internal measurement is hard to verify: this problem is true both for researcher surveys and governmental reporting requirements.

1.2.4.4 Superseded studies

In order to make our estimate as relevant for 2022 as possible, we have used the latest available estimate of food waste available in each country. As previously mentioned, a few countries have repeated estimates of food waste to provide a time series (such as the UK or Japan). When an estimate for which we have *High* confidence was available, this was taken and prior studies were not considered.

In the cases of *Medium confidence* estimates, where multiple *Medium confidence* estimates exist but they are not directly comparable to one another (such as Iraq (Yasir and Abudi, 2009; Sulaymon, Ibraheem and Graimed, 2010; Al-Maliky and ElKhayat, 2012; Al-Rawi and Al-Tayyar, 2013; Al-Mas'udi and Al-Haydari, 2015) which has distinct studies across a range of cities) the average of all of the relevant datapoints was taken to form the estimate.

As a result of this 'superseding' process, many studies are excluded from the calculations due to their being older than comparable studies. Therefore, the total number of food waste quantification studies originally considered is much higher than those in the final calculations. Similarly, due to prioritising *High confidence* estimates, all *Medium confidence* estimates in countries and sectors with *High* estimates were superseded, meaning a wealth of additional sub-national estimates exist beyond the final list of estimates. This is particularly the case in Europe, where copious research was overlooked with preference given to the official statistics reported to the European Commission.

1.3 Calculations: quantifying food waste in each country

This section details the calculation methods used to obtain an estimate of food waste for each country in the world, for each of the three sectors under consideration.

Multiple methods were trialled to explore their appropriateness to meet the objectives of this study. The method in this section was assessed to be the most accurate and most appropriate given the nature of the data collected. These are discussed in the Food Waste Index Report (2021) technical appendix.

The method used for household is different from the other two sectors, so is presented separately. This reflects the low data coverage for non-household sectors outside the HIC bracket. This data scarcity means that the estimates for the non-household sectors have low accuracy and therefore

[5] (Cicatiello, 2018; Delley and Brunner, 2018; Giordano *et al.*, 2018; For discussions on survey methodology, see: van Herpen *et al.*, 2019)

have a confidence level of Very Low. This reflects the substantial assumptions required to obtain these estimates. They are intended to give an approximate indication of the scale of the problem where these assumptions hold true. Without more data, we cannot say with confidence whether these estimates under- or over-state the true scale of the food waste problem.

1.3.1 Household

There are two broad approaches to obtaining a household-food waste estimate for a given country. This depends on whether a country has an estimate of food waste (classified as either High or Medium confidence) or no usable data for quantification purposes.

- **Countries with data**: For countries with a single usable estimate of household food waste, this is taken as the estimate for that country. When a country has multiple estimates (e.g. multiple household studies have been undertaken and we have a similar level of confidence in each), the average (mean) of those estimates is taken. If *High* confidence estimates existed for a country and sector, any *Medium* confidence estimates were removed, so averaging only happens at the same confidence level. See 1.2.4.4 for detail on when studies were superseded and when they were grouped. Only nationwide studies are considered *High* confidence to reduce possible bias from sub-national studies overrepresenting specific population groups, although sampling methodologies and in-country variation may still lead to uncertainty in the results.
- **Countries without data**: For countries without a usable study, we calculate an extrapolation using data from similar countries. For this calculation, two figures are calculated, and the average taken:

  The average waste (kg / capita / year) for data points from all countries with estimates in the same income group as the country in question (using World Bank classification)[6] and

  The average waste (kg / capita / year) for data points from all countries with estimates in the same region of the country in question (using UNSD sub-region).

  These two figures are averaged (i.e., combined with equal weight) to generate an estimate for the country:

$$Extrapolated\ estimate = (Avg.incomegroup * 50\%) + (Avg.Region * 50\%)$$

All averages are means. If there is no regional average, the income group average alone is used to inform the extrapolated estimate.

Due to the small number of estimates in Low-Income Countries (LICs), the income group average for LICs is calculated by averaging the data points for Low-Medium Income Countries (LMCs) and LICs into a single figure. Table 5 displays the average per capita waste by income group.

Table 5: Average household food waste per capita, by World Bank income group

Income group	Avg HHFW (kg/capita/year)
HIC	81

[6] 'Income group' refers to World Bank classification, for the 2024 fiscal year. There are four categories: Low-income countries (LIC), defined as those with Gross National Income (GNI) per capita of $1,135 or less; lower-middle income countries (LMC), with GNI between $1,136 and $4,465; upper-middle income countries (UMC) with a GNI per capita between $4,466 and $13,845; high-income countries (HIC), those with GNI per capita of $13,846 or more.

UMC	88
LMC	86
LIC*	91

Some countries do not have a World Bank income group classification. These territories were not provided with an estimate in the *Food Waste Index report 2021*. Due to the greater regional coverage of household estimates in the 2024 report, these countries and territories now have estimates calculated as well. Any studies identified in the country are prioritised. In the absence of country-specific data, the average household figure for the sub-region is taken. If no sub-regional estimates exist, then the global average is taken. All extrapolated figures for these countries are given 'Very Low Confidence'.

Table 7 displays the average per capita waste by region. For a discussion of some of the specific regions and the papers used to inform the estimates, see Chapter 1 of the main FWI report. Whilst the calculations are based on the averages presented in Table 6, the small number of datapoints for many regions and differences in methodology mean that they cannot be confidently compared.

Table 6: Average household food waste per capita, by region

	Number of countries with estimates informing average	**Average household waste generation**
Northern Africa	3	140
Sub-Saharan Africa	14	93
Latin America and the Caribbean	10	95
Northern America	2	76
Central Asia	0	N/A
Eastern Asia	5	70
South-eastern Asia	8	70
Southern Asia	7	100
Western Asia	9	116
Eastern Europe	6	53
Northern Europe	9	69
Southern Europe	8	83
Western Europe	7	80
Australia and New Zealand	2	79
Melanesia	2	92
Micronesia	1	38
Polynesia	0	N/A

Because the income groups typically include more countries than the regions, in nearly all cases the country has more estimates from similar income level countries than it does for countries within its region. As a result, by applying the average of the region and income group evenly, each regional estimate is given more weight than economic group estimates. The extent of the bias towards regional estimates depends on the number of papers in each category. This is considered justifiable as there are more likely to be regional similarities in diet and food culture (and thus food waste) than there are between geographically dispersed countries of similar income.

Countries which are in both the same income group and region are counted twice, once in the regional and once in the income average. As a result, this 'double-weights' the data from these countries. This is again considered justifiable as the data is coming from countries most alike to that in question.

We assess our confidence in the extrapolated estimates based on the number of countries which inform the extrapolation. None of the extrapolations are considered High or Medium confidence estimates, as these classifications are reserved for countries in which a study was identified. Extrapolations with low confidence are those which are informed by at least ten countries in total of which at least five must be countries from the same region. These are based on countries rather than datapoints, so even if a country in the same region had five studies informing its estimate, this would only count as one for the purposes of extrapolation. All extrapolations in LICs are Very Low due to having to use averages largely derived from LMCs.

1.3.2 Retail and Food Service

For non-household sectors (i.e., retail and Food Service), the data coverage geographically and across income levels is insufficient to fully replicate the approach taken for households. There are three ways in which country estimates have been made:

- **Countries with data:** Similar to the method used for households, if a country has usable estimate(s) of food waste in that sector, this is taken as the estimate for that country. As with household, when a country has multiple estimates, the average (mean) of those estimates is taken. Where a country has a *High* confidence estimate for a sector, this is prioritised and *Medium* confidence estimates are not included. These are classified as either *High* or *Medium* confidence depending on the method and scope of the study (see section 1.2.3).
- **High-income countries without data:** For HICs, there is sufficient data to extrapolate to other HICs without data. This extrapolation uses the average (mean) per capita waste of HICs with data. There is insufficient information in most regions to support the use of regional estimates in this extrapolation. These estimates are classed as 'low' confidence.
- **Other countries without data:** For UMCs, LMCs and LICs the average per capita waste for all countries with estimates is taken. This amounts to a very rough global average being used for the extrapolation. These estimates have a *Very Low* confidence classification.

As previously mentioned, the method for non-HICs is will result in estimates with **very low levels of accuracy**. For these countries, the global average used for extrapolation is mainly based on data from HICs, which may not be suitable proxies, hence the *Very Low* confidence classification.

Some countries do not have a World Bank income group classification. These territories were not provided with an estimate in the *Food Waste Index report 2021*. These are provided with estimates in the 2024 report. Any studies identified in the country are prioritised. In the absence of country-specific data, the global average is taken. All extrapolated figures are given 'Very Low Confidence'.

1.3.3 Calculating confidence per sector

Four confidence brackets are applied. *High* and *Medium* correspond to when a country has an existing estimate, with classification of that estimate corresponding to the boundaries set out in section 1.2.3. *Low* and *Very Low* confidence are calculated differently for household and non-household sectors, as outlined in Sections 1.3.1 and 1.3.2 respectively. This categorisation is summarised in Table 7.

Table 7: Description of confidence classification in this study

	When the classification has been used for…		Approximate confidence interval	Suitable for tracking?
	… Household	… Food Service and retail		
High Confidence	If there is a country-specific high confidence estimate		Often in range ±10-20%. See specific study for value or data to calculate CI	Highly likely
Medium Confidence	If there is a country-specific medium confidence estimate and no high confidence estimate		Often in range ±20-50%. See specific study for value or data to calculate CI	Possibly for larger changes in FW, although study may have potential for higher accuracy and / or comparability with other countries
Low Confidence	Extrapolation from estimates from at least 10 similar countries, of which at least five are in the same region	Extrapolation with sufficient estimates in income classification (i.e., for HIC countries)	Around ±50%	No – but may provide approximate estimate to inform FW-prevention strategy
Very Low Confidence	All others: Extrapolation from few than 10 estimates or fewer than five from the same region	All others: extrapolation for non-HIC countries	At least ±50%	No – but may provide very approximate estimate to inform FW-prevention strategy

The confidence rating in this report is not a judgement on the quality of the study undertaken. It is an assessment – based on our understanding of the study – of how robust the estimate of food waste is for tracking food waste in the given country. In many cases, this was not an aim of the original study. Hence many good studies will be classified at a Medium confidence level (or even excluded from consideration altogether) as the aims of the paper did not include national food-waste tracking.

2 Appendix: Possibly useful subsector studies

This Appendix contains a list of studies, grouped by region and country, which may be of use for government officials and researchers working on food waste quantification in those countries and regions. They are quantification studies which are useful but incomplete for the purposes of the Food Waste Index. As detailed in the main report, there are two primary scenarios in which papers have possibly-useful data which cannot be directly applied.

2.1 Data for a particular subsector

Firstly, a common situation is for an academic to have undertaken a study in a particular setting, such as supermarkets, restaurants or university canteens. These quantification studies often meet the criteria for developing national estimates. However, to contribute to a national estimate, two key additional steps are needed. **Firstly**, the estimates must be *scaled* to be nationally-representative. **Secondly**, they must be combined with estimates from other relevant subsectors to form an estimate of the whole sector.

For the first step, scaling: many studies report their results as the waste per establishment, or waste per customer, staff member or meal. To form national estimates, these *normalised* estimates need to be scaled by a relevant national statistic such as the number of restaurants, number of students or number of hotel guests nationally in a year. The process of normalising and scaling measurements is described in Chapter 2 of the main report.

For the second step, additional research: When research is done on a particular subsector, it is unlikely to tell the whole picture of the retail or Food Service sector in a country. Supermarkets are often not the only retail channel, particularly where public/farmer's markets play a large role. Similarly, restaurants or university canteens are only subsectors in a larger Food Service sector: to get an accurate estimate for the whole sector, it is likely that measurement would be needed in other sectors such as hotels or schools. This may be available from other studies, or it may need to be conducted independently.

In these situations, existing studies, when recent and robust, could help reduce the burden on conducting new studies for an initial baseline.

The results below were identified during the search process for the Level 1 estimates and are not necessarily exhaustive of all studies conducted within a country or region. Practitioners working in a particular country are encouraged to conduct their own research for additional resources.

Table 8: Table of subsector-specific studies

Source	**Country**	**Sector(s) covered**
(Li *et al.*, 2003)	*Air travel*	In-flight waste
(Perera and Kirupananda, 2023)	*Air Travel*	Airline industry
(Zotesso *et al.*, 2016)	Brazil	university cafeteria
(de Oliveira Pontes *et al.*, 2022)	Brazil	Industrial restaurants
(Pistorello, Conto and Zaro, 2015)	Brazil	Hotel
(Qian *et al.*, 2021)	China	University
(Qian *et al.*, 2022)	China	University
(Pan *et al.*, 2022)	China	University
(Ofei *et al.*, 2014)	Denmark	Hospital
(Elnasr, Aliane and Agina, 2021)	Egypt	All-inclusive hotels
(Srinivasa Reddy *et al.*, 2003)	India	Ship waste
(Sharma *et al.*, 2021)	India	Food Delivery apps
(Ramamoorthy, Poyyamoli and Kumar, 2019)	India	Schools
(Hartono, Kristanto and Amin, 2015)	Indonesia	Compares supermarket and traditional market
(Taghipour and Mosaferi, 2009)	Iran	Hospitals
(Abdulredha *et al.*, 2018)	Iraq	Hotels during religious festivals
(Saidan, Drais and Al-Manaseer, 2017)	Jordan	Refugee camp
(Zeineddine *et al.*, 2021)	Lebanon	Restaurants
(Chalak *et al.*, 2021)	Lebanon	Mezze restaurants
(Kamaruddin *et al.*, 2019)	Malaysia	University café
(Azura Zakarya *et al.*, 2020)	Malaysia	College cafeterias
(Chua *et al.*, 2019)	Malaysia	Hospital Waste

(Samah, Abd Hamid and Ishak, 2015)	Malaysia	Two different cafes at University Putra Malaysia
(Aguilar-Virgen *et al.*, 2017)	Mexico	Student housing
(Carpio-Aguilar, Rincón-Moreno and Franco-García, 2019)	Mexico	Walmart supermarket
(Adeniyi and Afon, 2022)	Nigeria	University
(Abdelaal, McKay and Mackey, 2019)	Qatar	University campuses
(Filimonau, Ermolaev and Vasyukova, 2022)	Russia	kindergartens
(Painter, Thondhlana and Kua, 2016)	South Africa	University dining halls
(Li and Jenq, 1993)	Taiwan, China	Hospital
(Wu and Teng, 2022)	Taiwan, China	Buffet restaurants
(Yi-Chi Chang, Lin and Hsiao, 2022)	Taiwan, China	Buffet restaurants
(Altin *et al.*, 2002)	Turkey	Hospitals
(Ozcicek-Dolekoglu and IŞIL VAR, 2019)	Turkey	University dining halls
(Zhao and Manning, 2019)	UK	University plate waste
(Baldwin and Dripps, 2012)	US	University campus

2.2 Data which needs disaggregating

In other scenarios, data has been directly measured at retail and Food Service establishments, but the results of these data analyses have been grouped into a single 'Commercial' estimate, sometimes termed 'Industrial, Commercial and Institutional' (ICI) or similar. This is particularly common in the context of studies which are looking at Municipal Solid Waste (MSW) generation by source, many of which have household data which is usable for the Food Waste Index. In these situations, the purpose of the original data collection was not for food waste reporting, but this existing data may be applicable.

In situations where waste was sampled from a range of different establishments, and raw data on waste generation is available at the level of those establishments, it may be possible to re-calculate the waste generation based on the type of establishment.

A fictitious example is displayed in Table 9, which shows fourteen business establishments whose waste was sampled. In an MSW study, the total 'waste per establishment' may be presented. Although composition data was gathered for specific businesses (column B), this may not have been stated in the original study, with only the total composition reported (in this case, 50% food waste based on the weighted average). However, the raw data from the sampling may be usable for the purposes of generating food waste estimates: if grouped by business type, the variation in particular subsectors can be better observed, and subsequently scaled to form a national estimate. Larger samples would be expected for most national studies, this example is just to demonstrate the logic.

Table 9: Example of re-calculating ICI data from MSW studies for use in the Food Waste Index. Data is illustrative and not intended to represent actual generation rates of these subsectors.

Establishment	kg waste generated / day (A)	ICI 'waste per establishment' (Mean of A)	Composition information, % food waste (B)	kg food waste per day (A*B)	Sector for Food Waste Index	Subsector	Subsector average food waste kg/day
Supermarket 1	30	39.3	80%	24	Retail	Supermarket	30.75
Supermarket 2	50		75%	37.5	Retail	Supermarket	
Restaurant 1	70		60%	42	Food Service	Restaurant	35.92
Restaurant 2	40		90%	36	Food Service	Restaurant	
Restaurant 3	35		85%	29.75	Food Service	Restaurant	
Hotel 1	55		50%	27.5	Food Service	Accommodation	19.75
Hotel 2	20		60%	12	Food Service	Accommodation	
School 1	25		20%	5	Food Service	Education	4.75
School 2	30		15%	4.5	Food Service	Education	
Hospital 1	60		10%	6	Food Service	Healthcare	6
Market 1	30		70%	21	Retail	Market	24
Market 2	30		90%	27	Retail	Market	
Clothes shop 1	50		0%	0	Not in scope	Not in scope	
Electronics shop 1	25		0%	0	Not in scope	Not in scope	

Some studies included in the *Food Waste Index* due to their household estimate also involved study of ICI waste which was not disaggregated, and therefore the data could not be directly used for estimates in retail and Food Service. Revisiting the raw data from these studies could inform the creation of Food Service and retail estimates in these countries. A list of some of these studies is presented below:

- (Environment Unit, no date), Solomon Islands
- (Aguilar, Moreno and Moreno Pérez, 2017), Chiapas, Mexico
- (Inter-American Development Bank *et al.*, 2022)
- (JICA, 2022), Ethiopia

2.3 Bibliography

This bibliography contains all of the studies referenced in the Appendices. For a list only of the references used to inform the Level 1 analysis, see the spreadsheet published alongside the report.

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3 Appendix: Level 1 data by country for all sectors

3.1 Household estimates

Region	M49 code	Country	Household estimate (kg/capita/year)	Household estimate (tonnes/year)	Confidence in estimate
Australia and New Zealand	36	Australia	98	2,559,065	High confidence
Australia and New Zealand	554	New Zealand	61	316,590	High confidence
Central Asia	398	Kazakhstan	88	1,708,990	Very Low Confidence
Central Asia	417	Kyrgyzstan	86	568,288	Very Low Confidence
Central Asia	762	Tajikistan	86	852,861	Very Low Confidence
Central Asia	795	Turkmenistan	88	566,433	Very Low Confidence
Central Asia	860	Uzbekistan	86	2,968,299	Very Low Confidence
Eastern Asia	156	China	76	108,667,369	Medium confidence
Eastern Asia	344	China, Hong Kong SAR	101	759,923	Medium confidence
Eastern Asia	446	China, Macao SAR	76	53,016	Low Confidence
Eastern Asia	408	Dem. People's Rep. Korea	81	2,104,855	Low Confidence
Eastern Asia	392	Japan	60	7,398,006	High confidence
Eastern Asia	496	Mongolia	18	60,364	Medium confidence
Eastern Asia	410	Republic of Korea	95	4,921,086	Medium confidence
Eastern Europe	112	Belarus	71	674,104	Low Confidence
Eastern Europe	100	Bulgaria	26	176,280	Eurostat
Eastern Europe	203	Czechia	69	723,810	Eurostat
Eastern Europe	348	Hungary	66	658,020	Eurostat
Eastern Europe	616	Poland	60	2,391,600	Eurostat
Eastern Europe	498	Republic of Moldova	71	231,061	Low Confidence
Eastern Europe	642	Romania	67	1,323,991	Low Confidence
Eastern Europe	643	Russian Federation	33	4,829,772	Medium confidence
Eastern Europe	703	Slovakia	65	366,600	Eurostat
Eastern Europe	804	Ukraine	69	2,758,037	Low Confidence
Latin America and the Caribbean	660	Anguilla	95	1,892	Very Low Confidence

Latin America and the Caribbean	28	Antigua and Barbuda	88	7,922	Low Confidence
Latin America and the Caribbean	32	Argentina	91	4,156,798	Low Confidence
Latin America and the Caribbean	533	Aruba	88	9,682	Low Confidence
Latin America and the Caribbean	44	Bahamas	88	36,089	Low Confidence
Latin America and the Caribbean	52	Barbados	88	24,646	Low Confidence
Latin America and the Caribbean	84	Belize	53	21,596	Medium confidence
Latin America and the Caribbean	68	Bolivia (Plurin. State of)	90	1,101,625	Low Confidence
Latin America and the Caribbean	535	Bonaire, St. Eustatius & Saba	95	2,838	Very Low Confidence
Latin America and the Caribbean	76	Brazil	94	20,289,630	Medium confidence
Latin America and the Caribbean	92	British Virgin Islands	88	2,641	Low Confidence
Latin America and the Caribbean	136	Cayman Islands	88	6,162	Low Confidence
Latin America and the Caribbean	152	Chile	88	1,725,226	Low Confidence
Latin America and the Caribbean	170	Colombia	70	3,653,302	Medium confidence
Latin America and the Caribbean	188	Costa Rica	91	473,131	Low Confidence
Latin America and the Caribbean	192	Cuba	91	1,023,900	Low Confidence
Latin America and the Caribbean	531	Curaçao	88	16,724	Low Confidence
Latin America and the Caribbean	212	Dominica	91	6,394	Low Confidence
Latin America and the Caribbean	214	Dominican Republic	160	1,799,544	Medium confidence
Latin America and the Caribbean	218	Ecuador	96	1,727,535	Medium confidence
Latin America and the Caribbean	222	El Salvador	91	579,084	Low Confidence
Latin America and the Caribbean	238	Falkland Islands (Malvinas)	95	-	Very Low Confidence
Latin America and the Caribbean	254	French Guiana	95	28,375	Very Low Confidence
Latin America and the Caribbean	308	Grenada	91	11,874	Low Confidence
Latin America and the Caribbean	312	Guadeloupe	95	37,834	Very Low Confidence
Latin America and the Caribbean	320	Guatemala	91	1,629,472	Low Confidence
Latin America and the Caribbean	328	Guyana	88	71,298	Low Confidence
Latin America and the Caribbean	332	Haiti	90	1,044,831	Low Confidence
Latin America and the Caribbean	340	Honduras	90	940,257	Low Confidence
Latin America and the Caribbean	388	Jamaica	86	243,364	High confidence
Latin America and the Caribbean	474	Martinique	95	34,996	Very Low Confidence

Latin America and the Caribbean	484	Mexico	105	13,368,447	Medium confidence
Latin America and the Caribbean	500	Montserrat	95	-	Very Low Confidence
Latin America and the Caribbean	558	Nicaragua	90	626,538	Low Confidence
Latin America and the Caribbean	591	Panama	101	445,347	Medium confidence
Latin America and the Caribbean	600	Paraguay	91	619,272	Low Confidence
Latin America and the Caribbean	604	Peru	88	2,983,735	Medium confidence
Latin America and the Caribbean	630	Puerto Rico	88	286,071	Low Confidence
Latin America and the Caribbean	652	Saint Barthélemy	95	946	Very Low Confidence
Latin America and the Caribbean	659	Saint Kitts and Nevis	88	4,401	Low Confidence
Latin America and the Caribbean	662	Saint Lucia	91	16,441	Low Confidence
Latin America and the Caribbean	663	Saint Martin (French part)	88	2,641	Low Confidence
Latin America and the Caribbean	670	Saint Vincent & Grenadines	91	9,134	Low Confidence
Latin America and the Caribbean	534	Sint Maarten (Dutch part)	88	3,521	Low Confidence
Latin America and the Caribbean	740	Suriname	91	56,630	Low Confidence
Latin America and the Caribbean	780	Trinidad and Tobago	88	134,673	Low Confidence
Latin America and the Caribbean	796	Turks and Caicos Islands	88	4,401	Low Confidence
Latin America and the Caribbean	850	United States Virgin Islands	88	8,802	Low Confidence
Latin America and the Caribbean	858	Uruguay	88	301,034	Low Confidence
Latin America and the Caribbean	862	Venezuela (Boliv. Rep. of)	93	2,626,859	Medium confidence
Melanesia	242	Fiji	90	83,945	Very Low Confidence
Melanesia	540	New Caledonia	87	25,215	Very Low Confidence
Melanesia	598	Papua New Guinea	89	903,213	Very Low Confidence
Melanesia	90	Solomon Islands	43	31,242	Medium confidence
Melanesia	548	Vanuatu	141	46,687	Medium confidence
Micronesia	316	Guam	60	10,173	Very Low Confidence
Micronesia	296	Kiribati	62	8,056	Very Low Confidence
Micronesia	584	Marshall Islands	63	2,526	Very Low Confidence
Micronesia	583	Micronesia (Fed. States of)	38	4,205	Medium confidence
Micronesia	520	Nauru	60	598	Very Low Confidence
Micronesia	580	Northern Mariana Islands	60	2,992	Very Low Confidence

Micronesia	585	Palau	63	1,263	Very Low Confidence
Northern Africa	12	Algeria	113	5,057,909	Very Low Confidence
Northern Africa	818	Egypt	163	18,085,437	Medium confidence
Northern Africa	434	Libya	84	572,937	Medium confidence
Northern Africa	504	Morocco	113	4,219,805	Very Low Confidence
Northern Africa	729	Sudan	116	5,414,527	Very Low Confidence
Northern Africa	788	Tunisia	172	2,121,810	Medium confidence
Northern Africa	732	Western Sahara	140	80,958	Very Low Confidence
Northern America	60	Bermuda	79	4,718	Very Low Confidence
Northern America	124	Canada	79	3,019,925	High confidence
Northern America	304	Greenland	79	4,718	Very Low Confidence
Northern America	666	Saint Pierre and Miquelon	76	758	Very Low Confidence
Northern America	840	United States of America	73	24,716,539	High confidence
Northern Europe	208	Denmark	79	464,520	Eurostat
Northern Europe	233	Estonia	61	81,130	Eurostat
Northern Europe	234	Faroe Islands	75	3,768	Low Confidence
Northern Europe	246	Finland	53	293,620	Eurostat
Northern Europe	352	Iceland	75	27,886	Low Confidence
Northern Europe	372	Ireland	48	240,960	Eurostat
Northern Europe	833	Isle of Man	75	6,029	Low Confidence
Northern Europe	428	Latvia	82	151,700	Eurostat
Northern Europe	440	Lithuania	86	236,500	Eurostat
Northern Europe	578	Norway	78	423,540	Eurostat
Northern Europe	752	Sweden	61	643,550	Eurostat
Northern Europe	826	United Kingdom	76	5,097,005	High confidence
Polynesia	16	American Samoa	81	3,258	Very Low Confidence
Polynesia	184	Cook Islands	86	1,724	Very Low Confidence
Polynesia	258	French Polynesia	81	25,252	Very Low Confidence
Polynesia	570	Niue	86	-	Very Low Confidence
Polynesia	882	Samoa	86	18,857	Very Low Confidence

Polynesia	772	Tokelau	86	-	Very Low Confidence
Polynesia	776	Tonga	88	9,690	Very Low Confidence
Polynesia	798	Tuvalu	88	881	Very Low Confidence
Polynesia	876	Wallis and Futuna Islands	86	862	Very Low Confidence
South-eastern Asia	96	Brunei Darussalam	76	34,109	Low Confidence
South-eastern Asia	116	Cambodia	85	1,419,831	Medium confidence
South-eastern Asia	360	Indonesia	53	14,728,364	Medium confidence
South-eastern Asia	418	Lao People's Dem. Rep.	89	673,831	Medium confidence
South-eastern Asia	458	Malaysia	81	2,754,808	Medium confidence
South-eastern Asia	104	Myanmar	78	4,221,946	Low Confidence
South-eastern Asia	608	Philippines	26	2,954,580	Medium confidence
South-eastern Asia	702	Singapore	68	409,182	Medium confidence
South-eastern Asia	764	Thailand	86	6,180,468	Medium confidence
South-eastern Asia	626	Timor-Leste	78	104,419	Low Confidence
South-eastern Asia	704	Viet Nam	72	7,079,811	Medium confidence
Southern Asia	4	Afghanistan	127	5,229,654	Medium confidence
Southern Asia	50	Bangladesh	82	14,101,956	Medium confidence
Southern Asia	64	Bhutan	19	15,072	High confidence
Southern Asia	356	India	55	78,192,338	Medium confidence
Southern Asia	364	Iran (Islamic Republic of)	93	8,208,360	Low Confidence
Southern Asia	462	Maldives	207	107,877	Medium confidence
Southern Asia	524	Nepal	93	2,831,907	Low Confidence
Southern Asia	586	Pakistan	130	30,754,726	Medium confidence
Southern Asia	144	Sri Lanka	76	1,656,148	Medium confidence
Southern Europe	8	Albania	86	243,657	Low Confidence
Southern Europe	20	Andorra	82	6,598	Low Confidence
Southern Europe	70	Bosnia and Herzegovina	86	277,117	Low Confidence
Southern Europe	191	Croatia	53	213,590	Eurostat
Southern Europe	292	Gibraltar	82	2,474	Low Confidence
Southern Europe	300	Greece	87	903,930	Eurostat

Southern Europe	336	Holy See	83	-	Very Low Confidence
Southern Europe	380	Italy	107	6,317,280	Eurostat
Southern Europe	470	Malta	92	48,760	Eurostat
Southern Europe	499	Montenegro	86	54,051	Low Confidence
Southern Europe	807	North Macedonia	86	179,311	Low Confidence
Southern Europe	620	Portugal	124	1,273,480	Eurostat
Southern Europe	674	San Marino	82	2,474	Low Confidence
Southern Europe	688	Serbia	108	780,482	Medium confidence
Southern Europe	705	Slovenia	36	76,320	Eurostat
Southern Europe	724	Spain	61	2,895,272	Eurostat
Sub-Saharan Africa	24	Angola	89	3,171,950	Low Confidence
Sub-Saharan Africa	204	Benin	89	1,189,816	Low Confidence
Sub-Saharan Africa	72	Botswana	50	132,594	Medium confidence
Sub-Saharan Africa	854	Burkina Faso	92	2,085,610	Low Confidence
Sub-Saharan Africa	108	Burundi	92	1,185,863	Low Confidence
Sub-Saharan Africa	132	Cabo Verde	89	52,584	Low Confidence
Sub-Saharan Africa	120	Cameroon	89	2,487,472	Low Confidence
Sub-Saharan Africa	140	Central African Republic	92	513,353	Low Confidence
Sub-Saharan Africa	148	Chad	92	1,630,217	Low Confidence
Sub-Saharan Africa	174	Comoros	89	74,865	Low Confidence
Sub-Saharan Africa	178	Congo	89	532,075	Low Confidence
Sub-Saharan Africa	384	Côte d'Ivoire	89	2,509,753	Low Confidence
Sub-Saharan Africa	180	Dem. Rep. of the Congo	62	6,147,778	Medium confidence
Sub-Saharan Africa	262	Djibouti	89	99,820	Low Confidence
Sub-Saharan Africa	226	Equatorial Guinea	90	150,824	Low Confidence
Sub-Saharan Africa	232	Eritrea	92	338,555	Low Confidence
Sub-Saharan Africa	748	Eswatini	89	106,950	Low Confidence
Sub-Saharan Africa	231	Ethiopia	69	8,543,382	Medium confidence
Sub-Saharan Africa	266	Gabon	90	215,849	Low Confidence
Sub-Saharan Africa	270	Gambia	92	249,316	Low Confidence

Sub-Saharan Africa	288	Ghana	84	2,812,571	High confidence
Sub-Saharan Africa	324	Guinea	89	1,235,269	Low Confidence
Sub-Saharan Africa	624	Guinea-Bissau	92	194,117	Low Confidence
Sub-Saharan Africa	404	Kenya	81	4,351,168	Medium confidence
Sub-Saharan Africa	426	Lesotho	89	205,878	Low Confidence
Sub-Saharan Africa	430	Liberia	92	487,593	Low Confidence
Sub-Saharan Africa	450	Madagascar	92	2,724,081	Low Confidence
Sub-Saharan Africa	454	Malawi	92	1,877,693	Low Confidence
Sub-Saharan Africa	466	Mali	92	2,078,251	Low Confidence
Sub-Saharan Africa	478	Mauritania	89	422,451	Low Confidence
Sub-Saharan Africa	480	Mauritius	90	117,408	Low Confidence
Sub-Saharan Africa	175	Mayotte	93	30,536	Very Low Confidence
Sub-Saharan Africa	508	Mozambique	92	3,033,197	Low Confidence
Sub-Saharan Africa	516	Namibia	90	232,106	Low Confidence
Sub-Saharan Africa	562	Niger	92	2,411,286	Low Confidence
Sub-Saharan Africa	566	Nigeria	113	24,791,826	Medium confidence
Sub-Saharan Africa	638	Réunion	93	89,759	Very Low Confidence
Sub-Saharan Africa	646	Rwanda	141	1,937,761	Medium confidence
Sub-Saharan Africa	654	Saint Helena	93	925	Very Low Confidence
Sub-Saharan Africa	678	Sao Tome and Principe	89	20,499	Low Confidence
Sub-Saharan Africa	686	Senegal	77	1,328,487	Medium confidence
Sub-Saharan Africa	690	Seychelles	183	20,089	Medium confidence
Sub-Saharan Africa	694	Sierra Leone	92	792,109	Low Confidence
Sub-Saharan Africa	706	Somalia	92	1,619,177	Low Confidence
Sub-Saharan Africa	710	South Africa	47	2,819,981	Medium confidence
Sub-Saharan Africa	728	South Sudan	92	1,003,706	Low Confidence
Sub-Saharan Africa	768	Togo	92	814,188	Low Confidence
Sub-Saharan Africa	800	Uganda	110	5,209,076	Medium confidence
Sub-Saharan Africa	834	United Rep. of Tanzania	152	9,960,496	Medium confidence
Sub-Saharan Africa	894	Zambia	78	1,559,958	Medium confidence

Sub-Saharan Africa	716	Zimbabwe	48	791,249	Medium confidence
Western Asia	51	Armenia	102	283,222	Low Confidence
Western Asia	31	Azerbaijan	102	1,055,462	Low Confidence
Western Asia	48	Bahrain	132	193,612	Medium confidence
Western Asia	196	Cyprus	71	88,750	Eurostat
Western Asia	268	Georgia	101	377,643	Medium confidence
Western Asia	368	Iraq	143	6,378,198	Medium confidence
Western Asia	376	Israel	97	874,433	Medium confidence
Western Asia	400	Jordan	101	1,136,788	Low Confidence
Western Asia	414	Kuwait	99	420,861	Low Confidence
Western Asia	422	Lebanon	128	701,828	Medium confidence
Western Asia	512	Oman	99	451,415	Low Confidence
Western Asia	634	Qatar	93	250,830	High confidence
Western Asia	682	Saudi Arabia	105	3,818,681	High confidence
Western Asia	275	State of Palestine	102	534,863	Low Confidence
Western Asia	760	Syrian Arab Republic	172	3,798,032	Medium confidence
Western Asia	792	Turkey	102	8,694,318	Low Confidence
Western Asia	784	United Arab Emirates	99	930,427	Low Confidence
Western Asia	887	Yemen	104	3,490,097	Low Confidence
Western Europe	40	Austria	83	742,020	Eurostat
Western Europe	56	Belgium	71	827,860	Eurostat
Western Europe	250	France	61	3,942,430	Eurostat
Western Europe	276	Germany	78	6,502,860	Eurostat
Western Europe	438	Liechtenstein	81	3,235	Low Confidence
Western Europe	442	Luxembourg	91	59,150	Eurostat
Western Europe	492	Monaco	81	3,235	Low Confidence
Western Europe	528	Netherlands	59	1,036,040	Eurostat
Western Europe	756	Switzerland	119	1,041,879	Medium confidence

3.2 Food Service estimates

Region	M49 code	Country	Food service estimate (kg/capita/year)	Food service estimate (tonnes/year)	Confidence in estimate
Australia and New Zealand	36	Australia	58	1,524,669	High confidence
Australia and New Zealand	554	New Zealand	39	204,552	Very Low Confidence
Central Asia	398	Kazakhstan	31	595,583	Very Low Confidence
Central Asia	417	Kyrgyzstan	31	206,441	Very Low Confidence
Central Asia	762	Tajikistan	31	309,818	Very Low Confidence
Central Asia	795	Turkmenistan	31	197,402	Very Low Confidence
Central Asia	860	Uzbekistan	31	1,078,289	Very Low Confidence
Eastern Asia	156	China	46	65,071,246	High confidence
Eastern Asia	344	China, Hong Kong SAR	25	185,069	Very Low Confidence
Eastern Asia	446	China, Macao SAR	25	17,296	Very Low Confidence
Eastern Asia	408	Dem. People's Rep. Korea	30	781,678	Very Low Confidence
Eastern Asia	392	Japan	12	1,490,488	High confidence
Eastern Asia	496	Mongolia	30	101,945	Very Low Confidence
Eastern Asia	410	Republic of Korea	25	1,280,410	Very Low Confidence
Eastern Europe	112	Belarus	17	164,273	Low Confidence
Eastern Europe	100	Bulgaria	2	13,560	Eurostat
Eastern Europe	203	Czechia	4	41,960	Eurostat
Eastern Europe	348	Hungary	2	19,940	Eurostat
Eastern Europe	616	Poland	5	199,300	Eurostat
Eastern Europe	498	Republic of Moldova	17	56,308	Low Confidence
Eastern Europe	642	Romania	12	239,125	Low Confidence
Eastern Europe	643	Russian Federation	8	1,220,199	Medium confidence

Eastern Europe	703	Slovakia	1	5,640	Eurostat
Eastern Europe	804	Ukraine	17	692,291	Very Low Confidence
Latin America and the Caribbean	660	Anguilla	23	456	Very Low Confidence
Latin America and the Caribbean	28	Antigua and Barbuda	42	3,824	Very Low Confidence
Latin America and the Caribbean	32	Argentina	48	2,163,862	Very Low Confidence
Latin America and the Caribbean	533	Aruba	42	4,674	Very Low Confidence
Latin America and the Caribbean	44	Bahamas	42	17,421	Very Low Confidence
Latin America and the Caribbean	52	Barbados	42	11,897	Very Low Confidence
Latin America and the Caribbean	84	Belize	48	19,494	Very Low Confidence
Latin America and the Caribbean	68	Bolivia (Plurin. State of)	48	583,696	Very Low Confidence
Latin America and the Caribbean	535	Bonaire, St. Eustatius & Saba	23	685	Very Low Confidence
Latin America and the Caribbean	76	Brazil	48	10,237,337	Very Low Confidence
Latin America and the Caribbean	92	British Virgin Islands	42	1,275	Very Low Confidence
Latin America and the Caribbean	136	Cayman Islands	42	2,974	Very Low Confidence
Latin America and the Caribbean	152	Chile	42	832,815	Very Low Confidence
Latin America and the Caribbean	170	Colombia	48	2,466,261	Very Low Confidence
Latin America and the Caribbean	188	Costa Rica	48	246,293	Very Low Confidence
Latin America and the Caribbean	192	Cuba	48	533,001	Very Low Confidence
Latin America and the Caribbean	531	Curaçao	42	8,073	Very Low Confidence
Latin America and the Caribbean	212	Dominica	48	3,328	Very Low Confidence
Latin America and the Caribbean	214	Dominican Republic	48	533,952	Very Low Confidence
Latin America and the Caribbean	218	Ecuador	48	855,845	Very Low Confidence

Latin America and the Caribbean	222	El Salvador	48	301,448	Very Low Confidence
Latin America and the Caribbean	238	Falkland Islands (Malvinas)	23	-	Very Low Confidence
Latin America and the Caribbean	254	French Guiana	23	6,845	Very Low Confidence
Latin America and the Caribbean	308	Grenada	48	6,181	Very Low Confidence
Latin America and the Caribbean	312	Guadeloupe	23	9,127	Very Low Confidence
Latin America and the Caribbean	320	Guatemala	48	848,238	Very Low Confidence
Latin America and the Caribbean	328	Guyana	42	34,417	Very Low Confidence
Latin America and the Caribbean	332	Haiti	48	553,603	Very Low Confidence
Latin America and the Caribbean	340	Honduras	48	498,195	Very Low Confidence
Latin America and the Caribbean	388	Jamaica	48	134,558	Very Low Confidence
Latin America and the Caribbean	474	Martinique	23	8,443	Very Low Confidence
Latin America and the Caribbean	484	Mexico	64	8,210,204	Medium confidence
Latin America and the Caribbean	500	Montserrat	23	-	Very Low Confidence
Latin America and the Caribbean	558	Nicaragua	48	331,971	Very Low Confidence
Latin America and the Caribbean	591	Panama	42	187,383	Very Low Confidence
Latin America and the Caribbean	600	Paraguay	48	322,368	Very Low Confidence
Latin America and the Caribbean	604	Peru	48	1,618,974	Very Low Confidence
Latin America and the Caribbean	630	Puerto Rico	42	138,094	Very Low Confidence
Latin America and the Caribbean	652	Saint Barthélemy	23	228	Very Low Confidence
Latin America and the Caribbean	659	Saint Kitts and Nevis	42	2,125	Very Low Confidence
Latin America and the Caribbean	662	Saint Lucia	48	8,558	Very Low Confidence
Latin America and the Caribbean	663	Saint Martin (French part)	42	1,275	Very Low Confidence

Latin America and the Caribbean	670	Saint Vincent & Grenadines	48	4,755	Very Low Confidence
Latin America and the Caribbean	534	Sint Maarten (Dutch part)	42	1,700	Very Low Confidence
Latin America and the Caribbean	740	Suriname	48	29,479	Very Low Confidence
Latin America and the Caribbean	780	Trinidad and Tobago	42	65,011	Very Low Confidence
Latin America and the Caribbean	796	Turks and Caicos Islands	42	2,125	Very Low Confidence
Latin America and the Caribbean	850	United States Virgin Islands	42	4,249	Very Low Confidence
Latin America and the Caribbean	858	Uruguay	42	145,318	Very Low Confidence
Latin America and the Caribbean	862	Venezuela (Boliv. Rep. of)	23	645,747	Very Low Confidence
Melanesia	242	Fiji	31	28,551	Very Low Confidence
Melanesia	540	New Caledonia	21	5,970	Very Low Confidence
Melanesia	598	Papua New Guinea	31	315,734	Very Low Confidence
Melanesia	90	Solomon Islands	31	22,419	Very Low Confidence
Melanesia	548	Vanuatu	31	10,275	Very Low Confidence
Micronesia	316	Guam	21	3,500	Very Low Confidence
Micronesia	296	Kiribati	31	4,048	Very Low Confidence
Micronesia	584	Marshall Islands	31	1,228	Very Low Confidence
Micronesia	583	Micronesia (Fed. States of)	31	3,425	Very Low Confidence
Micronesia	520	Nauru	21	206	Very Low Confidence
Micronesia	580	Northern Mariana Islands	21	1,029	Very Low Confidence
Micronesia	585	Palau	31	614	Very Low Confidence
Northern Africa	12	Algeria	31	1,398,071	Very Low Confidence
Northern Africa	818	Egypt	31	3,455,944	Very Low Confidence

Northern Africa	434	Libya	31	209,068	Very Low Confidence
Northern Africa	504	Morocco	31	1,166,408	Very Low Confidence
Northern Africa	729	Sudan	31	1,459,412	Very Low Confidence
Northern Africa	788	Tunisia	31	384,859	Very Low Confidence
Northern Africa	732	Western Sahara	23	13,234	Very Low Confidence
Northern America	60	Bermuda	49	2,919	Very Low Confidence
Northern America	124	Canada	80	3,064,632	Medium confidence
Northern America	304	Greenland	49	2,919	Very Low Confidence
Northern America	666	Saint Pierre and Miquelon	23	228	Very Low Confidence
Northern America	840	United States of America	74	24,939,986	High confidence
Northern Europe	208	Denmark	11	64,680	Eurostat
Northern Europe	233	Estonia	8	10,640	Eurostat
Northern Europe	234	Faroe Islands	18	885	Low Confidence
Northern Europe	246	Finland	14	77,560	Eurostat
Northern Europe	352	Iceland	18	6,547	Low Confidence
Northern Europe	372	Ireland	36	180,720	Eurostat
Northern Europe	833	Isle of Man	18	1,415	Low Confidence
Northern Europe	428	Latvia	19	35,150	Eurostat
Northern Europe	440	Lithuania	2	5,500	Eurostat
Northern Europe	578	Norway	18	97,740	Eurostat
Northern Europe	752	Sweden	9	94,950	Eurostat
Northern Europe	826	United Kingdom	16	1,093,662	High confidence
Polynesia	16	American Samoa	21	823	Very Low Confidence
Polynesia	184	Cook Islands	23	456	Very Low Confidence
Polynesia	258	French Polynesia	21	6,382	Very Low Confidence

Polynesia	570	Niue	23	-	Very Low Confidence
Polynesia	882	Samoa	31	6,850	Very Low Confidence
Polynesia	772	Tokelau	23	-	Very Low Confidence
Polynesia	776	Tonga	31	3,377	Very Low Confidence
Polynesia	798	Tuvalu	31	307	Very Low Confidence
Polynesia	876	Wallis and Futuna Islands	23	228	Very Low Confidence
South-eastern Asia	96	Brunei Darussalam	35	15,776	Very Low Confidence
South-eastern Asia	116	Cambodia	40	676,397	Very Low Confidence
South-eastern Asia	360	Indonesia	40	11,051,710	Very Low Confidence
South-eastern Asia	418	Lao People's Dem. Rep.	40	303,713	Very Low Confidence
South-eastern Asia	458	Malaysia	50	1,681,049	Medium confidence
South-eastern Asia	104	Myanmar	40	2,185,282	Very Low Confidence
South-eastern Asia	608	Philippines	40	4,660,966	Very Low Confidence
South-eastern Asia	702	Singapore	35	209,651	Very Low Confidence
South-eastern Asia	764	Thailand	40	2,876,253	Very Low Confidence
South-eastern Asia	626	Timor-Leste	40	54,047	Very Low Confidence
South-eastern Asia	704	Viet Nam	40	3,960,369	Very Low Confidence
Southern Asia	4	Afghanistan	32	1,336,124	Very Low Confidence
Southern Asia	50	Bangladesh	32	5,561,174	Very Low Confidence
Southern Asia	64	Bhutan	32	25,339	Very Low Confidence
Southern Asia	356	India	32	46,037,319	Very Low Confidence
Southern Asia	364	Iran (Islamic Republic of)	32	2,876,581	Very Low Confidence

Southern Asia	462	Maldives	34	17,593	Medium confidence
Southern Asia	524	Nepal	32	992,429	Very Low Confidence
Southern Asia	586	Pakistan	32	7,660,705	Very Low Confidence
Southern Asia	144	Sri Lanka	32	709,156	Very Low Confidence
Southern Europe	8	Albania	25	69,686	Low Confidence
Southern Europe	20	Andorra	19	1,558	Low Confidence
Southern Europe	70	Bosnia and Herzegovina	25	79,256	Low Confidence
Southern Europe	191	Croatia	4	16,120	Eurostat
Southern Europe	292	Gibraltar	19	584	Low Confidence
Southern Europe	300	Greece	21	218,190	Eurostat
Southern Europe	336	Holy See	23	-	Very Low Confidence
Southern Europe	380	Italy	19	1,150,162	Low Confidence
Southern Europe	470	Malta	45	23,850	Eurostat
Southern Europe	499	Montenegro	25	15,459	Low Confidence
Southern Europe	807	North Macedonia	25	51,283	Low Confidence
Southern Europe	620	Portugal	23	236,210	Eurostat
Southern Europe	674	San Marino	19	584	Low Confidence
Southern Europe	688	Serbia	12	83,920	Medium confidence
Southern Europe	705	Slovenia	20	42,400	Eurostat
Southern Europe	724	Spain	4	190,240	Eurostat
Sub-Saharan Africa	24	Angola	31	1,108,181	Very Low Confidence
Sub-Saharan Africa	204	Benin	31	415,685	Very Low Confidence
Sub-Saharan Africa	72	Botswana	31	81,316	Very Low Confidence
Sub-Saharan Africa	854	Burkina Faso	31	705,886	Very Low Confidence
Sub-Saharan Africa	108	Burundi	31	401,362	Very Low Confidence

Sub-Saharan Africa	132	Cabo Verde	31	18,371	Very Low Confidence
Sub-Saharan Africa	120	Cameroon	31	869,046	Very Low Confidence
Sub-Saharan Africa	140	Central African Republic	31	173,747	Very Low Confidence
Sub-Saharan Africa	148	Chad	31	551,755	Very Low Confidence
Sub-Saharan Africa	174	Comoros	31	26,155	Very Low Confidence
Sub-Saharan Africa	178	Congo	31	185,891	Very Low Confidence
Sub-Saharan Africa	384	Côte d'Ivoire	31	876,830	Very Low Confidence
Sub-Saharan Africa	180	Dem. Rep. of the Congo	31	3,082,918	Very Low Confidence
Sub-Saharan Africa	262	Djibouti	31	34,874	Very Low Confidence
Sub-Saharan Africa	226	Equatorial Guinea	31	51,634	Very Low Confidence
Sub-Saharan Africa	232	Eritrea	31	114,586	Very Low Confidence
Sub-Saharan Africa	748	Eswatini	31	37,365	Very Low Confidence
Sub-Saharan Africa	231	Ethiopia	31	3,841,737	Very Low Confidence
Sub-Saharan Africa	266	Gabon	31	73,896	Very Low Confidence
Sub-Saharan Africa	270	Gambia	31	84,382	Very Low Confidence
Sub-Saharan Africa	288	Ghana	31	1,042,481	Very Low Confidence
Sub-Saharan Africa	324	Guinea	31	431,565	Very Low Confidence
Sub-Saharan Africa	624	Guinea-Bissau	31	65,700	Very Low Confidence
Sub-Saharan Africa	404	Kenya	31	1,682,356	Medium confidence
Sub-Saharan Africa	426	Lesotho	31	71,927	Very Low Confidence
Sub-Saharan Africa	430	Liberia	31	165,028	Very Low Confidence
Sub-Saharan Africa	450	Madagascar	31	921,980	Very Low Confidence

Sub-Saharan Africa	454	Malawi	31	635,515	Very Low Confidence
Sub-Saharan Africa	466	Mali	31	703,395	Very Low Confidence
Sub-Saharan Africa	478	Mauritania	31	147,591	Very Low Confidence
Sub-Saharan Africa	480	Mauritius	31	40,194	Very Low Confidence
Sub-Saharan Africa	175	Mayotte	23	7,530	Very Low Confidence
Sub-Saharan Africa	508	Mozambique	31	1,026,601	Very Low Confidence
Sub-Saharan Africa	516	Namibia	31	79,461	Very Low Confidence
Sub-Saharan Africa	562	Niger	31	816,112	Very Low Confidence
Sub-Saharan Africa	566	Nigeria	31	6,804,776	Very Low Confidence
Sub-Saharan Africa	638	Réunion	23	22,133	Very Low Confidence
Sub-Saharan Africa	646	Rwanda	31	429,074	Very Low Confidence
Sub-Saharan Africa	654	Saint Helena	23	228	Very Low Confidence
Sub-Saharan Africa	678	Sao Tome and Principe	31	7,162	Very Low Confidence
Sub-Saharan Africa	686	Senegal	31	539,300	Very Low Confidence
Sub-Saharan Africa	690	Seychelles	26	2,845	Very Low Confidence
Sub-Saharan Africa	694	Sierra Leone	31	268,093	Very Low Confidence
Sub-Saharan Africa	706	Somalia	31	548,019	Very Low Confidence
Sub-Saharan Africa	710	South Africa	31	1,851,727	Very Low Confidence
Sub-Saharan Africa	728	South Sudan	31	339,709	Very Low Confidence
Sub-Saharan Africa	768	Togo	31	275,566	Very Low Confidence
Sub-Saharan Africa	800	Uganda	31	1,471,244	Very Low Confidence
Sub-Saharan Africa	834	United Rep. of Tanzania	31	2,039,502	Very Low Confidence

Sub-Saharan Africa	894	Zambia	31	623,371	Very Low Confidence
Sub-Saharan Africa	716	Zimbabwe	31	508,163	Very Low Confidence
Western Asia	51	Armenia	29	81,737	Very Low Confidence
Western Asia	31	Azerbaijan	29	304,604	Very Low Confidence
Western Asia	48	Bahrain	24	35,788	Very Low Confidence
Western Asia	196	Cyprus	30	37,500	Eurostat
Western Asia	268	Georgia	29	109,963	Very Low Confidence
Western Asia	368	Iraq	30	1,341,832	Medium confidence
Western Asia	376	Israel	24	218,382	Medium confidence
Western Asia	400	Jordan	30	334,416	Very Low Confidence
Western Asia	414	Kuwait	24	103,955	Very Low Confidence
Western Asia	422	Lebanon	30	162,617	Very Low Confidence
Western Asia	512	Oman	24	111,502	Very Low Confidence
Western Asia	634	Qatar	24	65,733	Very Low Confidence
Western Asia	682	Saudi Arabia	24	886,420	Very Low Confidence
Western Asia	275	State of Palestine	29	154,360	Very Low Confidence
Western Asia	760	Syrian Arab Republic	30	655,502	Very Low Confidence
Western Asia	792	Turkey	29	2,509,158	Very Low Confidence
Western Asia	784	United Arab Emirates	24	229,822	Very Low Confidence
Western Asia	887	Yemen	30	998,212	Very Low Confidence
Western Europe	40	Austria	23	205,620	Eurostat
Western Europe	56	Belgium	8	93,280	Eurostat
Western Europe	250	France	16	1,034,080	Eurostat

Western Europe	276	Germany	22	1,834,140	Eurostat
Western Europe	438	Liechtenstein	19	751	Low Confidence
Western Europe	442	Luxembourg	14	9,100	Eurostat
Western Europe	492	Monaco	19	751	Low Confidence
Western Europe	528	Netherlands	5	87,800	Eurostat
Western Europe	756	Switzerland	31	268,739	Medium confidence

3.3 Retail estimates

Region	M49 code	Country	Retail estimate (kg/capita/year)	Retail estimate (tonnes/year)	Confidence in estimate
Australia and New Zealand	36	Australia	21	547,033	High confidence
Australia and New Zealand	554	New Zealand	3	16,193	High confidence
Central Asia	398	Kazakhstan	21	408,228	Very Low Confidence
Central Asia	417	Kyrgyzstan	10	64,164	Very Low Confidence
Central Asia	762	Tajikistan	10	96,295	Very Low Confidence
Central Asia	795	Turkmenistan	21	135,304	Very Low Confidence
Central Asia	860	Uzbekistan	10	335,145	Very Low Confidence
Eastern Asia	156	China	20	28,227,822	Medium confidence
Eastern Asia	344	China, Hong Kong SAR	14	102,909	Very Low Confidence
Eastern Asia	446	China, Macao SAR	14	9,618	Very Low Confidence
Eastern Asia	408	Dem. People's Rep. Korea	12	312,940	Very Low Confidence
Eastern Asia	392	Japan	9	1,098,567	High confidence
Eastern Asia	496	Mongolia	12	40,813	Very Low Confidence
Eastern Asia	410	Republic of Korea	14	711,981	Very Low Confidence
Eastern Europe	112	Belarus	14	129,564	Low Confidence
Eastern Europe	100	Bulgaria	2	13,560	Eurostat
Eastern Europe	203	Czechia	6	62,940	Eurostat
Eastern Europe	348	Hungary	4	39,880	Eurostat

Eastern Europe	616	Poland	8	318,880	Eurostat
Eastern Europe	498	Republic of Moldova	14	44,410	Low Confidence
Eastern Europe	642	Romania	10	189,413	Low Confidence
Eastern Europe	643	Russian Federation	14	1,985,118	Medium confidence
Eastern Europe	703	Slovakia	3	16,920	Eurostat
Eastern Europe	804	Ukraine	8	313,581	Very Low Confidence
Latin America and the Caribbean	660	Anguilla	14	288	Very Low Confidence
Latin America and the Caribbean	28	Antigua and Barbuda	15	1,355	Very Low Confidence
Latin America and the Caribbean	32	Argentina	3	125,444	High confidence
Latin America and the Caribbean	533	Aruba	15	1,656	Very Low Confidence
Latin America and the Caribbean	44	Bahamas	15	6,174	Very Low Confidence
Latin America and the Caribbean	52	Barbados	15	4,216	Very Low Confidence
Latin America and the Caribbean	84	Belize	19	7,792	Very Low Confidence
Latin America and the Caribbean	68	Bolivia (Plurin. State of)	13	162,803	Very Low Confidence
Latin America and the Caribbean	535	Bonaire, St. Eustatius & Saba	14	432	Very Low Confidence
Latin America and the Caribbean	76	Brazil	3	574,161	Medium confidence
Latin America and the Caribbean	92	British Virgin Islands	15	452	Very Low Confidence
Latin America and the Caribbean	136	Cayman Islands	15	1,054	Very Low Confidence
Latin America and the Caribbean	152	Chile	15	295,144	Very Low Confidence
Latin America and the Caribbean	170	Colombia	19	985,795	Very Low Confidence
Latin America and the Caribbean	188	Costa Rica	19	98,446	Very Low Confidence
Latin America and the Caribbean	192	Cuba	19	213,047	Very Low Confidence
Latin America and the Caribbean	531	Curaçao	15	2,861	Very Low Confidence
Latin America and the Caribbean	212	Dominica	19	1,330	Very Low Confidence
Latin America and the Caribbean	214	Dominican Republic	19	213,427	Very Low Confidence
Latin America and the Caribbean	218	Ecuador	19	342,092	Very Low Confidence
Latin America and the Caribbean	222	El Salvador	19	120,492	Very Low Confidence
Latin America and the Caribbean	238	Falkland Islands (Malvinas)	14	-	Very Low Confidence
Latin America and the Caribbean	254	French Guiana	14	4,319	Very Low Confidence
Latin America and the Caribbean	308	Grenada	19	2,471	Very Low Confidence

Latin America and the Caribbean	312	Guadeloupe	14	5,759	Very Low Confidence
Latin America and the Caribbean	320	Guatemala	19	339,051	Very Low Confidence
Latin America and the Caribbean	328	Guyana	15	12,197	Very Low Confidence
Latin America and the Caribbean	332	Haiti	13	154,410	Very Low Confidence
Latin America and the Caribbean	340	Honduras	13	138,956	Very Low Confidence
Latin America and the Caribbean	388	Jamaica	19	53,784	Very Low Confidence
Latin America and the Caribbean	474	Martinique	14	5,327	Very Low Confidence
Latin America and the Caribbean	484	Mexico	45	5,798,641	Medium confidence
Latin America and the Caribbean	500	Montserrat	14	-	Very Low Confidence
Latin America and the Caribbean	558	Nicaragua	13	92,593	Very Low Confidence
Latin America and the Caribbean	591	Panama	15	66,407	Very Low Confidence
Latin America and the Caribbean	600	Paraguay	19	128,855	Very Low Confidence
Latin America and the Caribbean	604	Peru	19	647,124	Very Low Confidence
Latin America and the Caribbean	630	Puerto Rico	15	48,940	Very Low Confidence
Latin America and the Caribbean	652	Saint Barthélemy	14	144	Very Low Confidence
Latin America and the Caribbean	659	Saint Kitts and Nevis	15	753	Very Low Confidence
Latin America and the Caribbean	662	Saint Lucia	19	3,421	Very Low Confidence
Latin America and the Caribbean	663	Saint Martin (French part)	15	452	Very Low Confidence
Latin America and the Caribbean	670	Saint Vincent & Grenadines	19	1,901	Very Low Confidence
Latin America and the Caribbean	534	Sint Maarten (Dutch part)	15	602	Very Low Confidence
Latin America and the Caribbean	740	Suriname	19	11,783	Very Low Confidence
Latin America and the Caribbean	780	Trinidad and Tobago	15	23,039	Very Low Confidence
Latin America and the Caribbean	796	Turks and Caicos Islands	15	753	Very Low Confidence
Latin America and the Caribbean	850	United States Virgin Islands	15	1,506	Very Low Confidence
Latin America and the Caribbean	858	Uruguay	15	51,500	Very Low Confidence
Latin America and the Caribbean	862	Venezuela (Boliv. Rep. of)	14	407,469	Very Low Confidence
Melanesia	242	Fiji	21	19,570	Very Low Confidence
Melanesia	540	New Caledonia	13	3,813	Very Low Confidence
Melanesia	598	Papua New Guinea	10	98,134	Very Low Confidence
Melanesia	90	Solomon Islands	10	6,968	Very Low Confidence

Melanesia	548	Vanuatu	10	3,194	Very Low Confidence
Micronesia	316	Guam	13	2,235	Very Low Confidence
Micronesia	296	Kiribati	10	1,258	Very Low Confidence
Micronesia	584	Marshall Islands	21	842	Very Low Confidence
Micronesia	583	Micronesia (Fed. States of)	10	1,065	Very Low Confidence
Micronesia	520	Nauru	13	131	Very Low Confidence
Micronesia	580	Northern Mariana Islands	13	657	Very Low Confidence
Micronesia	585	Palau	21	421	Very Low Confidence
Northern Africa	12	Algeria	10	434,537	Very Low Confidence
Northern Africa	818	Egypt	10	1,074,148	Very Low Confidence
Northern Africa	434	Libya	21	143,301	Very Low Confidence
Northern Africa	504	Morocco	10	362,533	Very Low Confidence
Northern Africa	729	Sudan	10	453,602	Very Low Confidence
Northern Africa	788	Tunisia	10	119,619	Very Low Confidence
Northern Africa	732	Western Sahara	14	8,351	Very Low Confidence
Northern America	60	Bermuda	17	1,020	Very Low Confidence
Northern America	124	Canada	30	1,146,937	Medium confidence
Northern America	304	Greenland	17	1,020	Very Low Confidence
Northern America	666	Saint Pierre and Miquelon	14	144	Very Low Confidence
Northern America	840	United States of America	12	4,011,424	High confidence
Northern Europe	208	Denmark	17	99,960	Eurostat
Northern Europe	233	Estonia	15	19,950	Eurostat
Northern Europe	234	Faroe Islands	12	594	Low Confidence
Northern Europe	246	Finland	10	55,400	Eurostat
Northern Europe	352	Iceland	12	4,396	Low Confidence
Northern Europe	372	Ireland	12	60,240	Eurostat
Northern Europe	833	Isle of Man	12	950	Low Confidence
Northern Europe	428	Latvia	8	14,800	Eurostat
Northern Europe	440	Lithuania	10	27,500	Eurostat
Northern Europe	578	Norway	11	59,730	Eurostat

Northern Europe	752	Sweden	9	94,950	Eurostat
Northern Europe	826	United Kingdom	4	236,285	High confidence
Polynesia	16	American Samoa	13	526	Very Low Confidence
Polynesia	184	Cook Islands	14	288	Very Low Confidence
Polynesia	258	French Polynesia	13	4,076	Very Low Confidence
Polynesia	570	Niue	14	-	Very Low Confidence
Polynesia	882	Samoa	10	2,129	Very Low Confidence
Polynesia	772	Tokelau	14	-	Very Low Confidence
Polynesia	776	Tonga	21	2,315	Very Low Confidence
Polynesia	798	Tuvalu	21	210	Very Low Confidence
Polynesia	876	Wallis and Futuna Islands	14	144	Very Low Confidence
South-eastern Asia	96	Brunei Darussalam	46	20,692	Very Low Confidence
South-eastern Asia	116	Cambodia	44	742,033	Very Low Confidence
South-eastern Asia	360	Indonesia	50	13,755,721	Very Low Confidence
South-eastern Asia	418	Lao People's Dem. Rep.	44	333,185	Very Low Confidence
South-eastern Asia	458	Malaysia	79	2,675,062	Medium confidence
South-eastern Asia	104	Myanmar	44	2,397,336	Very Low Confidence
South-eastern Asia	608	Philippines	44	5,113,255	Very Low Confidence
South-eastern Asia	702	Singapore	46	274,980	Very Low Confidence
South-eastern Asia	764	Thailand	50	3,579,983	Very Low Confidence
South-eastern Asia	626	Timor-Leste	44	59,292	Very Low Confidence
South-eastern Asia	704	Viet Nam	44	4,344,674	Very Low Confidence
Southern Asia	4	Afghanistan	10	398,051	Very Low Confidence
Southern Asia	50	Bangladesh	10	1,656,756	Very Low Confidence
Southern Asia	64	Bhutan	10	7,549	Very Low Confidence
Southern Asia	356	India	10	13,715,198	Very Low Confidence
Southern Asia	364	Iran (Islamic Republic of)	10	856,976	Very Low Confidence
Southern Asia	462	Maldives	21	10,942	Very Low Confidence
Southern Asia	524	Nepal	10	295,659	Very Low Confidence
Southern Asia	586	Pakistan	10	2,282,237	Very Low Confidence

Southern Asia	144	Sri Lanka	10	211,268	Very Low Confidence
Southern Europe	8	Albania	15	41,792	Low Confidence
Southern Europe	20	Andorra	11	862	Low Confidence
Southern Europe	70	Bosnia and Herzegovina	15	47,531	Low Confidence
Southern Europe	191	Croatia	1	4,030	Eurostat
Southern Europe	292	Gibraltar	11	323	Low Confidence
Southern Europe	300	Greece	14	145,460	Eurostat
Southern Europe	336	Holy See	14	-	Very Low Confidence
Southern Europe	380	Italy	6	354,240	Eurostat
Southern Europe	470	Malta	8	4,240	Eurostat
Southern Europe	499	Montenegro	15	9,271	Low Confidence
Southern Europe	807	North Macedonia	15	30,755	Low Confidence
Southern Europe	620	Portugal	21	215,670	Eurostat
Southern Europe	674	San Marino	11	323	Low Confidence
Southern Europe	688	Serbia	3	22,431	Low Confidence
Southern Europe	705	Slovenia	7	14,840	Eurostat
Southern Europe	724	Spain	7	332,920	Eurostat
Sub-Saharan Africa	24	Angola	10	344,436	Very Low Confidence
Sub-Saharan Africa	204	Benin	10	129,200	Very Low Confidence
Sub-Saharan Africa	72	Botswana	15	40,398	Very Low Confidence
Sub-Saharan Africa	854	Burkina Faso	10	219,397	Very Low Confidence
Sub-Saharan Africa	108	Burundi	10	124,748	Very Low Confidence
Sub-Saharan Africa	132	Cabo Verde	10	5,710	Very Low Confidence
Sub-Saharan Africa	120	Cameroon	10	270,110	Very Low Confidence
Sub-Saharan Africa	140	Central African Republic	10	54,003	Very Low Confidence
Sub-Saharan Africa	148	Chad	10	171,492	Very Low Confidence
Sub-Saharan Africa	174	Comoros	10	8,129	Very Low Confidence
Sub-Saharan Africa	178	Congo	10	57,777	Very Low Confidence
Sub-Saharan Africa	384	Côte d’Ivoire	10	272,529	Very Low Confidence
Sub-Saharan Africa	180	Dem. Rep. of the Congo	10	958,207	Very Low Confidence

Sub-Saharan Africa	262	Djibouti	10	10,839	Very Low Confidence
Sub-Saharan Africa	226	Equatorial Guinea	15	25,652	Very Low Confidence
Sub-Saharan Africa	232	Eritrea	10	35,615	Very Low Confidence
Sub-Saharan Africa	748	Eswatini	10	11,613	Very Low Confidence
Sub-Saharan Africa	231	Ethiopia	10	1,194,057	Very Low Confidence
Sub-Saharan Africa	266	Gabon	15	36,711	Very Low Confidence
Sub-Saharan Africa	270	Gambia	10	26,227	Very Low Confidence
Sub-Saharan Africa	288	Ghana	10	324,015	Very Low Confidence
Sub-Saharan Africa	324	Guinea	10	134,135	Very Low Confidence
Sub-Saharan Africa	624	Guinea-Bissau	10	20,420	Very Low Confidence
Sub-Saharan Africa	404	Kenya	11	592,374	Medium confidence
Sub-Saharan Africa	426	Lesotho	10	22,356	Very Low Confidence
Sub-Saharan Africa	430	Liberia	10	51,293	Very Low Confidence
Sub-Saharan Africa	450	Madagascar	10	286,562	Very Low Confidence
Sub-Saharan Africa	454	Malawi	10	197,525	Very Low Confidence
Sub-Saharan Africa	466	Mali	10	218,623	Very Low Confidence
Sub-Saharan Africa	478	Mauritania	10	45,873	Very Low Confidence
Sub-Saharan Africa	480	Mauritius	15	19,968	Very Low Confidence
Sub-Saharan Africa	175	Mayotte	14	4,751	Very Low Confidence
Sub-Saharan Africa	508	Mozambique	10	319,080	Very Low Confidence
Sub-Saharan Africa	516	Namibia	15	39,476	Very Low Confidence
Sub-Saharan Africa	562	Niger	10	253,657	Very Low Confidence
Sub-Saharan Africa	566	Nigeria	10	2,115,003	Very Low Confidence
Sub-Saharan Africa	638	Réunion	14	13,966	Very Low Confidence
Sub-Saharan Africa	646	Rwanda	10	133,361	Very Low Confidence
Sub-Saharan Africa	654	Saint Helena	14	144	Very Low Confidence
Sub-Saharan Africa	678	Sao Tome and Principe	10	2,226	Very Low Confidence
Sub-Saharan Africa	686	Senegal	10	167,621	Very Low Confidence
Sub-Saharan Africa	690	Seychelles	11	1,255	Very Low Confidence
Sub-Saharan Africa	694	Sierra Leone	10	83,327	Very Low Confidence

Sub-Saharan Africa	706	Somalia	10	170,331	Very Low Confidence
Sub-Saharan Africa	710	South Africa	15	919,927	Very Low Confidence
Sub-Saharan Africa	728	South Sudan	10	105,586	Very Low Confidence
Sub-Saharan Africa	768	Togo	10	85,649	Very Low Confidence
Sub-Saharan Africa	800	Uganda	10	457,280	Very Low Confidence
Sub-Saharan Africa	834	United Rep. of Tanzania	10	633,901	Very Low Confidence
Sub-Saharan Africa	894	Zambia	10	193,751	Very Low Confidence
Sub-Saharan Africa	716	Zimbabwe	8	136,957	Medium confidence
Western Asia	51	Armenia	31	87,469	Very Low Confidence
Western Asia	31	Azerbaijan	31	325,963	Very Low Confidence
Western Asia	48	Bahrain	28	40,450	Very Low Confidence
Western Asia	196	Cyprus	56	70,000	Eurostat
Western Asia	268	Georgia	31	117,674	Very Low Confidence
Western Asia	368	Iraq	31	1,400,131	Very Low Confidence
Western Asia	376	Israel	50	452,000	Medium confidence
Western Asia	400	Jordan	26	291,070	Very Low Confidence
Western Asia	414	Kuwait	28	117,497	Very Low Confidence
Western Asia	422	Lebanon	26	141,539	Very Low Confidence
Western Asia	512	Oman	28	126,027	Very Low Confidence
Western Asia	634	Qatar	28	74,296	Very Low Confidence
Western Asia	682	Saudi Arabia	20	715,590	High confidence
Western Asia	275	State of Palestine	31	165,184	Very Low Confidence
Western Asia	760	Syrian Arab Republic	26	570,538	Very Low Confidence
Western Asia	792	Turkey	31	2,685,105	Very Low Confidence
Western Asia	784	United Arab Emirates	28	259,759	Very Low Confidence
Western Asia	887	Yemen	26	868,827	Very Low Confidence
Western Europe	40	Austria	9	80,460	Eurostat
Western Europe	56	Belgium	6	69,960	Eurostat
Western Europe	250	France	12	775,560	Eurostat
Western Europe	276	Germany	9	750,330	Eurostat

Western Europe	438	Liechtenstein	12	490	Low Confidence
Western Europe	442	Luxembourg	14	9,100	Eurostat
Western Europe	492	Monaco	12	490	Low Confidence
Western Europe	528	Netherlands	12	210,720	Eurostat
Western Europe	756	Switzerland	18	152,974	Medium confidence

4 Appendix: Measurement methods appropriate for each sector

The following methods have been deemed appropriate for each relevant sector for Level 2 and Level 3.

Table 10: Measurement methods for Manufacturing

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Volume assessment Weighing, of whole containers or samples	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a Public-Private Partnership) Directly commission studies and maintain oversight of estimates
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighings Volume assessment	
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, of samples or entire stream depending on feasibility Volume assessment	
Waste discharged to sewer (for Level 3)	Use of biological / chemical oxygen demand (BOD and COD), suspended solids (SS). For further advice see: https://www.wrap.org.uk/sites/files/wrap/food-waste-in-effluent-guidelines_1.pdf	
All waste streams	Waste coefficients applied to material flow Mass balance (i.e., inputs minus outputs)	

It is possible that food manufacture companies keep records of their waste already. Companies may call it something other than waste e.g., leakage, slippage, residue, etc. Therefore, a degree of relationship building and understanding between governments and food manufacturers/processors in the country may need to be built before either understands whether it is possible to use company records to build a national picture.

Informal food processing may not be at the scale necessary to quantify under 12.3.1(b) but this should be an informed decision. It is possible that informal processing occurs on farm or in some households as local business in rural areas. Food removed from the human supply chain in those cases may either be picked up in 12.3.1(b) or as part of in-home consumption under 'household' studies. If the latter, it may be useful to use diaries or surveys to determine how much food waste is likely to be discarded for that reason.

Table 11: Measurement methods for retail

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor (direct measurement) Waste composition analysis Scanning items as they are wasted Volume assessment Weighing, of whole containers or samples	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a Public-Private Partnership) Directly commission studies and maintain oversight of estimates
Food waste in a container (mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor (direct measurement) Waste composition analysis Scanning items as they are wasted	

The applicability of each method depends on the subsectors. Firstly, some more formal forms of retail, such as supermarkets and hypermarkets, are more likely to have systematic recording of records of products bought, sold and possibly wasted. Outdoor or informal street and farmers' markets are less likely to have these, so weighing or volumetric assessments are necessary. Secondly, the manner of scaling measurements will vary. If markets or specialist stores play a large role in the food retail of a country, an effort will have to be made to quantify the number and type of retailers across different geographic areas. This will help to determine a sample frame for the measurement studies and provide the basis for scaling. However, it is likely that the study on number and type of informal retailers will need to be repeated as a country's retail market changes between reporting periods.

Table 12: Measurement methods for food service

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from companies
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Scanning items as they are wasted	Use of nationally held records e.g., regulatory returns Audit (face-to-face survey) to take measurements Self-completion or telephone survey – to request/require provision of measurement data Data provision as part of a framework to tackle food waste (e.g., a Public-Private Partnership) Directly commission studies and maintain oversight of estimates
Food waste in a food waste-only container shared with other businesses or households	Volume assessment Weighing, of whole containers or samples *Intercepting waste when shared with other businesses or households*	
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighing Volume assessment *Intercepting waste when shared with other businesses or households*	
Food waste in a container mixed with other wastes and shared with other businesses or households		
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, via waste composition analysis or trial weighing Volume assessment	

The diversity of establishment types within this sector is such that records are unlikely to cover them all. Larger public establishments like hospitals or schools may have records or can be more easily regulated than private organisations. The restaurant subsector is likely to be diverse and made up of majority small and medium enterprises, many of which may be informal in some countries. Appropriate methods for measurement are therefore likely to be volume assessments or weighing in a sample study over a series of site visits. The same challenges for scaling such measurement studies apply here as for informal retail; getting as accurate an understanding of the quantity of waste-producing entities as possible is as important as the measurement study and not likely to be easy. This is directly linked to SDG 11.6.1 and could be measured as part of a waste composition analysis.

Table 13: Measurement methods for Household Sector

Waste stream	Appropriate measurement methods	Appropriate means for national government to obtain the measurements from relevant organisations
Food waste in a container (single stream – not mixed with other wastes)	Use of records specifying volume or mass e.g., from waste contractor Volume assessment Weighing, of whole containers or samples Food waste diaries	Collation of data from local/municipal, regional or state governments Commission organisation to conduct studies and scale up on behalf of governments Directly commission studies and maintain oversight of estimates
Food waste in a container (mixed with other wastes)	Weighing, via waste composition analysis or trial weighing (linked with SDG 11.6.1)	
Uncontained food waste (not mixed with other wastes and not discharged to sewer)	Weighing, via waste composition analysis or trial weighing (linked with SDG 11.6.1) Diaries Volume assessment	
Waste discharged to sewer (for Level 3) and food home composted, animal feed	Diaries Diversion and weighing	

Methods most appropriate for household food waste vary by the destination of that waste. If generation and collection are equivalent, then a synthesis of waste composition analyses of samples of collected waste from around the country with the total waste collected figure can give a relatively accurate picture of food waste generated in the home without conducting a household study. However, this will ignore the amount of waste composted at home. These amounts, if likely to be a smaller part of the waste stream, are likely best quantified by a diary study and scaled via population demographic statistics e.g., number of households. If they are likely to be a larger part of the food waste generated from households, a direct measurement study may be more appropriate using in-home observers or measurement devices. This is directly linked to SDG 11.6.1 and could be measured as part of a waste composition analysis.

5 Appendix: Destinations and food waste

Table 14: Definitions of food-waste destinations

Destination	Definition	Classified as food waste for the purposes of the FWI
Animal feed	Diverting material from the food supply chain[7] (directly or after processing) to food-producing animals.	N
Animal food	Diverting material from the food supply chain[7] (directly or after processing) to non-food-producing animals.	N
Bio-based materials/ biochemical processing	Converting material into industrial products for food and non-food purposes. Examples include creating fibres for packaging material; creating bioplastics (e.g., polylactic acid); making "traditional" materials such as leather or feathers (e.g., for pillows); and rendering fat, oil, or grease into a raw material to make products such as soaps, biodiesel, or cosmetics. "Biochemical processing" does not refer to anaerobic digestion or production of bioethanol through fermentation.	N
Codigestion/ anaerobic digestion	Breaking down material via bacteria in the absence of oxygen. This process generates biogas and nutrient-rich matter. Co-digestion refers to the simultaneous anaerobic digestion of FLW and other organic material in one digester. This destination includes fermentation (converting carbohydrates – such as glucose, fructose, and sucrose – via microbes into alcohols in the absence of oxygen to create products such as biofuels).	Y
Composting/ aerobic processes	Breaking down material via bacteria in oxygen-rich environments. Composting refers to the production of organic material (via aerobic processes) that can be used as a soil amendment.	Y
Controlled combustion	Sending material to a facility that is specifically designed for combustion in a controlled manner, which may include some form of energy recovery (this may also be referred to as incineration or thermal treatment).	Y
Land application	Spreading, spraying, injecting, or incorporating organic material onto or below the surface of the land to enhance soil quality.	Y
Landfill	Sending material to an area of land or an excavated site that is specifically designed and built to receive wastes.	Y
Not harvested/ ploughed-in	Leaving crops that were ready for harvest in the field or tilling them into the soil.	Not applicable
Refuse/ discards/ litter	Abandoning material on land or disposing of it in the sea. This includes open dumps (i.e., uncovered, unlined), open burn (i.e., not in a controlled facility), the portion of harvested crops eaten by pests, and fish discards (the portion of total catch that is thrown away or slipped).	Y
Sewer/ wastewater treatment	Sending material down the sewer (with or without prior treatment), including that which may go to a facility designed to treat wastewater.	Y
Other	Sending material to a destination that is different from the 10 listed above. This destination should be described.	N

[7] Excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use