Estimates of European food waste levels. Project report FUSIONS

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Estimates of European food waste levels

Reducing food waste through social innovation

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Colophon

Title	Estimates of European food waste levels
Authors	Åsa Stenmarck (IVL), Carl Jensen (IVL), Tom Quested (WRAP), Graham Moates (IFR). Contributing partners: Michael Buksti (Communique), Balázs Cseh (HFA), Selina Juul (SWF), Andrew Parry (WRAP), Alessandro Politano (UniBo), Barbara Redlingshofer (INRA), Silvia Scherhaufer (BOKU), Kirsi Silvennoinen (LUKE), Han Soethoudt (WageningenUR), Christine Zübert (UHOH), Karin Östergren (SP)
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Projectleader	FUSIONS coordinator: Toine Timmermans, Wageningen UR - Food Biobased Research, The Netherlands Project leader for this Deliverable: Åsa Stenmarck, IVL Swedish Environmental Research Institute (Sweden).
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Summary

Food waste is an issue of importance to global food security and good environmental governance, directly linked with environmental (e.g. energy, climate change, water, availability of resources), economic (e.g. resource efficiency, price volatility, increasing costs, consumption, waste management, commodity markets) and social (e.g. health, equality) impacts. Different studies show that between 1/3 and 1/2 of the world food production is not consumed (Gustavsson et al, 2011; Bio Intelligence study, 2010), leading to negative impacts throughout the food supply chain including households. There is a pressing need to prevent and reduce food waste to make the transition to a resource efficient Europe.

However, the data behind these figures comes from different sources, which use a variety of definitions for what is considered 'food waste'. In addition, different studies use different methods, which can affect the resultant estimates. The task described in this report is thus to obtain an EU-28 estimate for food waste, which aligns as closely as possible to the new FUSIONS definitional framework (Östergren et al, 2014) and uses data from robust and comparable methodologies. Data which was judged to be not sufficiently robust or containing other uncertainties was available from some countries and this data was excluded from this study. However the data might be useful for other purposes.

The report presents estimates for food waste arisings in the EU-28. Estimates of food waste were sought for 2013. However, in most cases such recent information was not available and most estimates were for 2012 or earlier. Therefore, the estimates produced are most closely aligned to 2012. In some cases newer information has been used as well.

It is clear that the data presented in this study have a relatively high uncertainty due to the limited number of underlying studies of sufficient quality available. However it should be acknowledged that this is the first attempt to do something like this i.e. building on existing data, adjusting that to a common definition and then finding valid ways of up-scaling and producing a EU-28 data set for food waste. Data can and will always be improved.

The estimates have been obtained using a combination of national waste statistics and findings from selected research studies. The data were collected from contacts within EU Member States (MS) using the process described in section 3. The data obtained were filtered according to quality thresholds in order to ensure that retained data were aligned to the FUSIONS food waste definition and used a robust methodology. Where there were gaps for individual MS, these were filled in, using processes described in the sections relating to each sector:

- Primary production
- Processing
- Wholesale and logistics combined with retail and markets[1]

1 The reason to combine wholesale and logistics with retail and markets is that throughout Europe the system works differently and the most comparable option are to have the two sectors combined.

- Food service
- Household

The collection and analysis of data from across Europe for this study generated an estimate of food waste in the EU-28 of 88 million tonnes (Table 1).This estimate is for 2012 and includes both edible food and inedible parts associated with food. This equates to 173 kilograms of food waste per person in the EU-28. The total amounts of food produced in EU for 2011 were around 865 kg / person[2], this would mean that in total we are wasting 20 % of the total food produced.

Table 1: Estimates of food waste in EU-28 in 2012 from this quantification study; includes food and inedible parts associated with food.

Sector	Food waste (million tonnes) with 95% CI*	Food waste (kg per person) with 95% CI*
Primary production	9.1 ± 1.5	18 ± 3
Processing	16.9± 12.7	33 ± 25
Wholesale and retail	4.6 ± 1.2	9 ± 2
Food service	10.5 ± 1.5	21 ± 3
Households	46.5 ±4.4	92 ± 9
Total food waste	**87.6 ± 13.7**	**173 ± 27**

**Confidence interval*

The sectors contributing the most to food waste are households (47 million tonnes ± 4 million tonnes) and processing (17 million tonnes ± 13 million tonnes). These two sectors account for 72 percent of EU food waste, although there is considerable uncertainty around the estimate for the processing sector compared to all the other sectors. This is due to only four MS providing information of sufficiently high quality. In addition the differences in the normalized food waste amounts between the countries were great. Of the remaining 28 percent of food waste 11 million tonnes (12%) comes from food service, 9 million tonnes (10%) comes from primary production and 5 million tonnes (5%) comes from wholesale and retail.

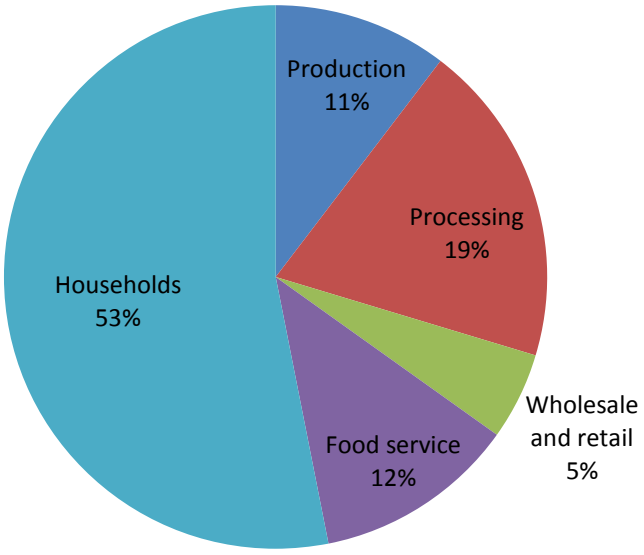


Figure 1: Split of EU-28 food waste in 2012 by sector; includes food and inedible parts associated with food.

[2] http://faostat3.fao.org/download/FB/FBS/E

In comparison with previously performed studies the results differ due to the various definitions used, sectors included etc.

The costs associated with food waste for EU-28 in 2012 are estimated at around 143 billion euros. Two-thirds of the costs are associated with food waste from households (around 98 billion euros). This is due to households a) having more edible food waste than any other sector and b) the costs associated with a tonne of food accumulating along the supply chain (e.g. processing, packaging, retailing costs).

There is moderately high uncertainty around this estimate of food waste amounts; the approximate 95% confidence interval is ±14 million tonnes (or ±16%). Therefore, the range of results within this confidence interval is from 74 million tonnes to 101 million tonnes. Regarding the different sectors the uncertainty varies, and it needs to be acknowledged that data might change significantly as more studies will be carried out.

The level of uncertainty seen in the results is due to only a small number of recent studies of sufficiently high quality being identified. Data were only obtained for up to a quarter of MS (the exact figure depending on the sector (See Annex E)) and the process of scaling the information from these MS to the whole EU-28 is responsible for this relatively large uncertainty. In addition, there was a bias in the MS reporting data towards larger countries and those in the North and West of the continent. This introduces further uncertainty, as these countries supplying data may not be fully representative of the rest of the EU-28. However, it is very difficult to quantify this type of uncertainty without further data and research.

Therefore, a key recommendation from this exercise for accurately quantifying food waste in Europe is to increase the number of EU MS that measure food waste robustly. This will be necessary if there is an EU food waste target that requires monitoring. This recommendation applies to all sectors; however, the lack of data was particularly acute for the processing sector as well as the primary production sector – there are very few measurements of waste in agriculture, horticulture, aquaculture, fisheries or other primary production activities and wide differences in the definition of food waste within this sector.

A more reliable reporting can be achieved by ensuring that those studies that do take place use a consistent definition of food waste (taken from the FUSIONS definitional framework), have robust sampling procedures in place, and use measurement methods that are accurate. More details to assist MS in achieving this are given in the FUSIONS food waste quantification manual. It can also be facilitated by ensuring that adequate funding is available for future food waste studies.

It is recommended that this task is repeated regularly when the manual is complete and MS have had an opportunity to implement it.

Contents

1 List of definitions

The definitions used were derived from the FUSIONS definitional framework. Please see the FUSIONS definitional framework and FUSIONS food waste quantification manual for further interpretations and delimitations.

- Food: Food means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be eaten by humans. 'Food' includes drink, chewing gum and any substance, including water, intentionally incorporated into food during its manufacture, preparation or treatment.

- Food supply chain: The food supply chain is the connected series of activities used to produce, process, distribute and consume food. Specific starting points of the food supply chain according to the FUSIONS theoretical framework are:
  - When crops are mature for harvest
  - When fruit and berries are mature for harvest
  - The harvesting of wild crops, fruit and berries
  - When animals are ready for slaughter (live-weight)
  - When wild animals are caught or killed (live-weight)
  - The drawing of milk from animals
  - When eggs are laid by the bird
  - The catching of wild fish in the net/on the hook
  - When fish from aquaculture is mature in the pond

- Food waste: Fractions of "food and inedible parts of food removed from the food supply chain" to be recovered or disposed (including - composted, crops ploughed in/not harvested, anaerobic digestion, bioenergy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea).

- Inedible parts of food: Inedible parts of food removed from the food supply chain

Normalisation factor: Factor used for upscaling of data.

2 Background

Food waste is an issue of importance to global food security and good environmental governance, directly linked with environmental (e.g. energy, climate change, availability of resources), economic (e.g. resource efficiency, price volatility, increasing costs, consumption, waste management, commodity markets) and social (e.g. health, equality) impacts. Different studies show that between 1/3 and 1/2 of the world food production is not consumed (Gustavsson et al, 2011; Bio Intelligence Service, 2010), leading to negative impacts throughout the food supply chain including households. There is a pressing need to prevent and reduce food waste to make the transition to a resource efficient Europe.

However, the data behind these figures comes from different sources, which use a variety of definitions for what is considered 'food waste'. In addition, different studies use different methods, which can affect the resultant estimates. The task described in this report is to obtain an EU-28 estimate for food waste, which aligns as closely as possible to the new FUSIONS definitional framework (Östergren et al, 2014) and using data from robust and comparable methodologies.

It was originally envisaged that this task would be undertaken after the FUSIONS food waste quantification manual was complete, and member states (MS) could use this manual to make estimates of food waste using the methods recommended in the manual and aligned to the FUSIONS definitional framework. This would have made it possible for this task to collect harmonised data from across the EU. However, this would have meant that the current task could not have been completed within the timespan of FUSIONS. Therefore, in this report an attempt has been made to align existing data as closely as possible to the FUSIONS food waste definition. Data which was judged to be not sufficiently robust or containing other uncertainties was available from some countries and these data were excluded from this study. However that data might be useful for other purposes. The methodology used is based on the work carried out within FUSIONS including "Standard approach on quantitative techniques to be used to estimate food waste levels" (Møller et al 2014a) and "Report on review of (food) waste reporting and practice" (Møller et al 2014b). The way of work has made it possible to be in line with other initiatives in the field and has given good input to the FUSIONS food waste quantification manual.

It is recommended that measurement of food waste, according to consistent definitions and methodology, is carried out by MS on a regular basis in order to support efforts to reduce/prevent food waste at national and EU levels and to facilitate sharing of data and experience across the MS. The tools developed by the FUSIONS project can assist MS in this task. That will hopefully give more harmonised data and data from a larger number of countries, both of which should decrease the uncertainty in the estimate of food waste.

3 Method

3.1 Overview of the method

This section describes the process whereby existing data on food waste has been collated from all Member States (MS) within the EU-28. Data was sought from FUSIONS partners and representatives within each MS Government responsible for reporting of waste statistics. Contact details within the individual MS were given by EUROSTAT.

The process to obtain and analyse data followed these steps:

1. Matrix for collection of information (development and data-collection) was sent to contacts described above. See section 3.3.
2. Collation of the information received. See section 3.4 and 3.5.
    - Clarification of definitions and methods with contacts
    - Filtering of data according to quality thresholds
3. Filling of data gaps. See section 3.4.2.
4. Use of the data to obtain EU estimates. See section 3.4.3 and 4.
5. Check of data with national food waste contact points.

Along with this work, two parallel data collections were carried out by other stakeholders:

- EUROSTAT has collected data in a special food waste plug in (connected to the Waste Statistics Regulation (WStatR)). Data from the plug-in was reported to EUROSTAT in June 2014 and contains data for 2012. Even though the plug-in data are more detailed than for previously collected data within WStatR the level of detail in the data on food waste collected is not sufficient for making an EU-estimate for food waste. This is because the reported waste codes (List of Waste codes specified in the Waste Framework Directive) include several types of organic waste besides food waste under one code. This means that the collected data cannot be used for measuring food waste and hence there is still a need for more precise data on the actual levels of food waste in the EU.
- OECD has compiled food waste data found for all member nations and sent this out for approval or adjustment by each country. The data have been made available for the FUSIONS team. Most of the data sources are the same as the data gathered within FUSIONS.

The data were collected within FUSIONS during autumn 2014 and revised during winter 2015 - 2016.

3.2 Sectors studied

The same sectors as chosen in "Standard approach on quantitative techniques to be used to estimate food waste levels" (Møller et al, 2014) have been used. The information asked for in all sheets corresponds to the parts of the food supply chain shown in Table 2.

Table 2: Sectors studied.

Sector	Place in value chain	NACE classification	NACE codes[3]
Primary production	Primary production (Agriculture and fisheries)	Agriculture, hunting and forestry	NACE 01-03
Processing	Food manufacturing	Manufacture of food products and beverages	NACE 10-11
Wholesale and logistics	Distribution	Wholesale trade, except of motor vehicles and motorcycles	NACE 46
Retail and Markets	Distribution	Retail trade, except of motor vehicles and motorcycles	NACE 47
Food service[1]	Consumption	Accommodation and food and beverage service activities	NACE 55-56[2]
Household	Consumption	NA[3]	NA[3]

1. Data from foodservice sector were collected either as a total for the sector or with a possibility to split between different subcategories (Hotel, Restaurants and Catering/Canteens) in the case that data were available for these specific activities.
2. The NACE classification system does not reflect the segmentation of the food supply chain adopted in FUSIONS. E.g. Not all activities included in the NACE codes 55-56 are food services.
3. There are no NACE codes for households.

The benefit of using the same classification as official statistics is that it is easier to find supporting statistics (e.g. to help normalise the data) and also there is a common understanding of the classifications. In brief, it gives the best opportunities for finding data. In discussion with the respondents, some would have preferred other divisions especially countries that sometimes have more detailed data for specific sub-groups. Sometimes there were only data available for a part of the sector, and this was harder to report in the matrix provided. More information on EU-statistics can be found in Møller et al 2014b.

The sectors 'Wholesale and logistics' and 'Retail and markets' were combined and regarded as one sector in the compilations. The reason being that, within the EU, the boundaries between these two sectors differ and more consistent data are obtained using the combined sectors compared to the individual sectors. Data were however collected separately for the two sectors.

In Møller et al (2014a) the activity of redistribution is described. It was therefore decided to include this in the investigation for data. However no data were available on amounts of food being redistributed and therefore this sector was completely left out in the

following work. The activity is considered to be small by comparison with total food production & consumption and does not have a large impact on the overall numbers. However there is a growing interest in these activities and recent findings are mentioned in chapter 4.7 but not up-scaled. By redistribution food is saved from being wasted and it is therefore interesting to be aware of these figures.

Feed (food going to animals) is not considered as waste in the FUSIONS food waste definition. Few studies have been made and the data found are reported in chapter 4.8. These data have not been used for upscaling.

3.3 Collecting data

In order to collect data in the first step, an Excel-based matrix was developed (Annex A-C). This was supplemented by short guidelines to facilitate the completion of the matrix (Annex D).

In short the matrix consists of three sheets:

1. Amounts of food waste generated from different sectors in the food value chain (Annex A)
2. The destinations for this food waste (e.g. whether going to landfill, anaerobic digestion, etc.) (Annex B)
3. The amount of food waste split into different product categories (the same as listed in D1.4) (Annex C)

The first sheet – amounts of food waste generated – is essential for the current task. However, as information was being sought, it was an opportunity to also ask for data on the destination of the waste and the food groups as well as for waste of different product groups.

The main structure of the sheets is the same; each sheet contain cells relating to the amount of waste, the degree of uncertainty, the quantification method, a reference for the study, the year of the estimate and the coverage of the data. Given that existing data were collected there has also been a need to include descriptions of what is meant by food waste in the different countries.

We asked specifically for data on liquid food waste that have been measured separately. Liquid food waste is often disposed of via the sewer (at least in households) and can, for example, consist of dairy products, beverages, oil and sauces. There is an increased interest in measuring this stream of food waste as it is not found together with the solid waste and thus normally does not get considered in the overall statistics.

Estimates of food waste were sought for 2013. However, in most cases such recent information was not available and most estimates were for 2012 or earlier. Therefore, the estimates produced are most closely aligned to 2012.

In the matrix we have asked the respondents to supply information on "food waste". The FUSIONS definition of food waste is explained in Figure 2.

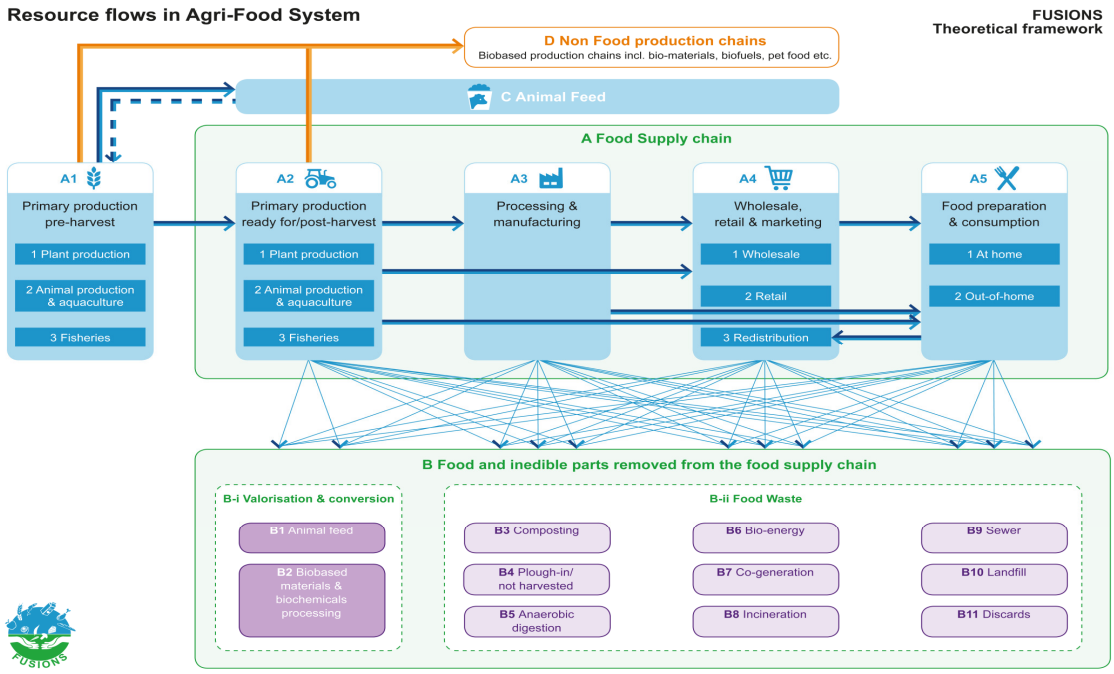


Figure 2. The FUSIONS technical framework defining the Food supply chain and Food waste (FUSIONS Technical Framework).

It was not possible to track food ending up in valorisation and conversion (Section B-i in Figure 2) with the given methodology. The main reason being that when using existing data, these streams are not well quantified.

As an explanation to the respondents on the inedible and edible parts, the following description was given: The food waste is divided into edible food products and inedible parts. They make up the total food waste for the respective part of the food supply chain.

As contacts were supplying existing information, it became clear that there were some discrepancies between the definition used for the estimates and the FUSIONS definitional framework. This has been handled with different measures, see section 3.4.

To be able to estimate the data for EU-28 in total, information such as population and produced food waste amounts were also collected, see section 3.4.2 for further details.

3.4 Processing and analysing data

This section describes the data that were received, the quality of that data and how it was analysed to obtain an estimate of food waste in the EU-28.

3.4.1 Data coverage and quality

Firstly, not all countries were able to submit data for all sectors requested. Table 3 gives the number of countries (out of a total of 28) supplying information on the total amount of food waste for a given sector. The countries providing data are shown in Annex E. Information at a more granular level (i.e., food waste by product group and by

destination of that waste) were provided by a smaller number of countries. However, since these two types of data were not within the focus of the current task, they were not used except as a guide to help validate data. In the FUSIONS framework, attention is given to the fact that one needs to know the destination of the waste to determine if it is a waste. Contacting the countries submitting data it became clear that many had a "waste generating perspective" instead of a "treatment perspective" but even so much data especially for the consumption sectors was based on waste treatment knowledge e.g. in households data are mostly based on waste data from municipal solid waste (MSW), home composting and waste poured down the sewer. Data based on a "waste generating perspective" was thus not a big issue for the consumption sectors. For the primary production and processing sector feeding to animals etc. do occur and according to the FUSIONS definitional framework it should not be accounted for as food waste. Most MS were however not able to clarify if such flows were included or not in the reported amounts which thus added to the uncertainties for the two sectors.

Table 3. Number of countries from which information about the generated food waste amounts was collected.

Sector	Number of countries submitting data	Number of countries submitting data of sufficient quality	NACE codes
Primary production	15	6	NACE 01-03
Processing	19	4	NACE 10-11
Wholesale and logistics and Retail and Markets	18[1]	11[2]	NACE 46 and 47
Food service	18	8	NACE 55-56
Household	19	11	NA

1. 18 countries supplied data from either the wholesale and logistics or the retail and market sector. Of those, four countries only submitted data from the retail and market sector. The remaining 14 countries submitted data for both the two sectors or the two sectors as a whole.
2. Of the 11 countries submitting data of sufficient quality three countries only submitted data from the retail and market sector. The remaining eight countries provided sufficient data for both the two sectors or the two sectors as a whole.
** Data from Norway has been collected but not used since they are not part of EU-28.*

As seen from Table 3, between one third and half of the countries within the EU were able to provide food waste data depending on the sector. Food waste for several countries was however rejected when scaling up the amounts to European level since they did not meet the set quality criteria. Some countries have also been regarded as "outliers" (meaning that they are too extreme in some way) and are therefore not included in the calculations. The household sector is one of the sectors with the largest number of studies available which might be because the household sector is of high importance when it comes to food waste.

For more information for each sector see further down in this section and Annex E.

All countries which submitted data were contacted again to clarify what the data covered. This was to better understand the data that had been submitted, how it compared to the FUSIONS definitional framework and what measurement methods had been used. This process helped to identify why there were differences in normalised amounts of food waste between countries.

Based on the information supplied by individual countries, and other investigations into the specific figures supplied by each country, data were assessed to see whether it was of suitably high quality to be used in the estimate of food waste for the EU-28. These investigations focused on the scope of the estimate (e.g. which parts of a sector had

been covered), what methods had been used to quantify food waste, the age of the estimate and the level of uncertainty associated with the estimate. These investigations were different for each sector, and details can be found in section 3.5.

3.4.2 Scaling data to EU-28

As the coverage of the data across the EU-28 countries was not complete, a process was required for each sector to scale up the data that were obtained to estimate food waste in the whole of the EU-28. As a first step, a review of on-line literature was undertaken to see if any estimates for food waste existed that were not provided previously.

Then for those countries where data were missing, these data gaps were filled in by calculating the 'normalised' level of food waste (e.g. food waste per person or food waste per produced amount), based on the countries that did supply data. These normalised levels of waste were then multiplied by the relevant quantity (e.g. population of the countries) to obtain the amount of waste generated for those countries without data. The normalised levels used might also not be fully representative of all countries. For example, since data are mostly provided by higher-income countries, the factors (e.g. food waste per person in households) might be less valid for lower-income countries.

A number of different normalisation factors (i.e. those used for upscaling) were considered for each sector. As described in Møller et al (2014a) there are several options for each sector. A choice was made relating to:

- How much the normalisation factor varies with amount of food waste; ideally the relationship is close to proportional
- Availability of data for the normalisation factor for all countries

The normalisation factors chosen were different for each sector. For instance, population (number of inhabitants) was selected for household food waste because, all other factors being equal, food waste is proportional to number of people. However, population is not appropriate for comparing countries' agricultural sectors, as the types and amount of agricultural production are not directly linked to the population of that country.

No normalisation factor is 'perfect' for filling in missing data. In some circumstances, different factors were assessed and the differences in the results compared. The normalisation for each sector is discussed in the relevant section for each sector, alongside comments about whether the process introduces any bias into the results. A summary of the normalisation factors is given in Table 4.

Table 4. Normalisation factors used to fill in data gaps for the different sectors studied.

FUSIONS denominations	Normalisation factor used to fill in data gaps	NACE codes
Primary production	Produced food amounts in this sector	NACE 01-03
Processing	Produced food amounts in this sector	NACE 10-11
Wholesale and logistics and Retail and Markets	Population	NACE 46-47
Food service	Turnover number[1]	NACE 55-56
Household	Population	NA[2]

[1] *The turnover number for the sector which was adjusted by the purchasing power parity (PPP). This was because different countries have different price levels which if not considered will have a negative effect of the quality of the normalized food waste amounts.*
[2] *There is no NACE code for households.*

The normalised factors used can be compared to the indicators suggested in Møller et al (2014a), see Table 5.

Table 5. Indicators suggested in Møller et al, 2014a.

Sector	Indicator	Unit
Primary production	Amount of food waste or any fraction of it / sold unit	Tonnes/ Euro
Processing	Amount of food waste (tonnes) / total manufactured food sold (tonnes)	Tonnes/ tonnes
Wholesale and logistics	Amount of food waste in mass per year / total input of food products in mass per year (kg food waste per kg input)	Kg/ kg
Retail and markets	Amount of food waste generated per year	Kg
	Amount of food waste / turnover	Kg/ Euro
	Amount of food waste per year / total input of (food) products in mass per year	Kg/kg
Redistribution	Amount of food waste generated per year	Kg
	if applicable, Amount of food waste / turnover	Kg/ Euro
	Amount of food waste per year / total input of (food) products in mass per year (kg secondary resources per kg input)	Kg/kg
Food service	Amount of food waste in food service *storage* / produced amount food in food services per country	Kg/kg
	Amount of food waste in food service *preparation* / produced amount food in food services	Kg/kg
	Amount of food waste in food service for *serving (plate leftover and display waste)* / produced amount food in food services	Kg/kg
Households	Amount of *total* food waste in household per person	Kg/ person
	Amount of *edible* food waste in household per person	Kg/ person

In practice, there are some differences between the normalisation factors suggested in Møller et al (2014a) and those used in this task:

- Primary production: produced food amounts were used instead of sold unit. It was thought there should be a linear correlation between the produced food amounts and the generated food waste amounts. Furthermore produced amounts are publically available through Eurostat and are updated on a continuous basis while sold amounts are not as easily available. This entails the risk that amounts going to feed or charity is included.

- Processing: produced food amounts were used instead of amount of food sold. As with the primary production sector the strategy was to choose a normalisation factor which correlates to the generated food waste amounts as much as possible. Also the public availability and the updating of data was another reason why the produced food amounts was chosen. This entails the risk that amounts going to feed or charity is included.
- Wholesale and retail: population was used instead of turnover or amount of sold products. This was because data on turnover number was not available exclusively for wholesale and retail related to the sale of food products but for all types of products. As there should be a correlation between the food waste amounts produced from the sector in a country and the population of that country (in the absence of significant cross-border sales) it was decided to use population as a normalisation factor, which also is publically available and updated on a regular basis by Eurostat.
- Food service: turnover was used instead of amounts of food served. This was because no public information about food amounts produced from the sector was found in the project. Based on discussions in the project, there should be a correlation between the food waste amounts and the turnover number taking into account the different price levels between EU countries.

3.4.3 Calculation of uncertainty

Uncertainty describes the difference between the estimate of food waste and the 'true' value of food waste that would have been measured with an infinitely accurate method. The difference between the two includes contributions from random uncertainties (e.g., from only sampling part of the population and then scaling up the results) and biases (e.g., using a quantification method such as kitchen diaries that are known to systematically underestimate waste levels).

The uncertainties associated with the key estimates in the report were explored and an attempt was made to quantify the main contributions. The uncertainty can be divided into two main types:

- Uncertainties associated with **individual studies** quantifying food waste in separate MS.
- Uncertainties associated with **scaling results to all MS** (i.e. to cover those MS without individual studies).

The uncertainties associated with individual studies include:

- Sampling error – due to obtaining food-waste data from a sample of businesses, organisations and households, rather than the complete 'population'. This type of uncertainty is largest for smaller sample sizes.
- Biases relating to sampling – the sample that was used may not have been representative of the wider population. For example, only larger businesses may have provided information in a study, and these companies may have had different levels of food waste than smaller companies, thus biasing the results.
- Biases relating to definition or coverage – for instance, some studies did not include some food waste covered by the FUSIONS definition (e.g. omitting food waste composted at home) and some studies included some material not covered by the FUSIONS definition. Steps were taken to minimise this error by confirming what was included in different studies and either correcting for differences or omitting studies as a result.

- Biases relating to measurement – some studies will have used methods to quantify waste that are less robust than others. For instance, quantifying food waste from households is more accurate using waste compositional analysis than kitchen diaries, which are more accurate than using questionnaire methods based on recall.

Most of the studies did not have an accurate estimate of uncertainty associated with them.

The uncertainties associated with scaling the results to all MS were obtained by calculating the standard error around the mean and multiplying by the appropriate value of *t* to obtain the 95% confidence interval. These confidence intervals should be considered approximate as they are based on small sample sizes; nevertheless, they gave an indication of the range of likely results if this exercise were to be repeated.

Using typical levels of uncertainty (taken from individual studies that did provide uncertainties), it was possible to show that most of the uncertainty was associated with scaling the results from a small number of MS to the whole of the EU-28. In the example in Table 6, the effect of varying the assumed level of uncertainty in individual studies (i.e. from those countries that did provide food waste data) from 0% to 15% is explored. This sensitivity analysis suggests that the uncertainty varies from ±4.43 million tonnes to ±4.85 million tonnes, a difference which is not of material importance given the overall level of uncertainty.

Table 6: Total level of uncertainty for household food waste for EU-28 for different assumed levels of uncertainties in individual studies

Assumed level of uncertainty in individual studies	Total 95% confidence interval from both individual studies and scaling to EU-28
0%	4.43 million
5%	4.48 million
10%	4.62 million
15%	4.85 million

This mini-investigation suggests that, as most of the uncertainty is associated with scaling estimates from a small number of countries to the rest of the EU-28, the approximate confidence intervals are not unduly influenced by the decision to omit the uncertainty contribution relating to individual studies.

3.4.4 Calculation of cost of food waste

The cost of food waste in the EU-28 was estimated from the data in this report. The basic method was to determine the proportion of food that is edible and apply a figure for the value of food waste per tonne of edible food waste to this figure. The estimate of cost was determined for each sector and then summed.

Information on the proportion of food waste that is edible is detailed in Table 7:

Table 7. Proportion of food waste.

Sector	Percentage of total food waste that is edible (%)	Source of data
Primary production	50	Assumption due to lack of data
Processing	50	Assumption due to lack of data
Wholesale and retail	83	Average of data supplied by EU-28 countries for this project
Food service	59	Average of data supplied by EU-28 countries for this project
Households	60	Average of data supplied by EU-28 countries for this project

Some of the studies from which these proportions were derived will have been performed before agreement was reached on the definition of food waste (and the edible fraction of this total). For this reason, there may be differences in the definition used to inform the study, influencing the results and the result should be seen as an estimate.

Table 8 below gives the cost per tonne of edible food waste by sector:

Table 8. Cost per tonne of edible food waste.

Sector	Cost per tonne of edible food waste (Euro)	Source of data
Primary production	399	Production weighted average of commodity prices for 18 agricultural food types in meat and dairy, 70 harvested cereals, grains, fruit and vegetables, and all aquaculture and fisheries output[3]
Processing	1 490	Production weighted average of sold prices for 233 food types in food processing and manufacturing[4]
Wholesale and retail	2 768	Assumes a 27.5% mark-up from supply of wholesale and retail to the final price (as charged to households)[5]
Food service	3 148	Average of wholesale & retail and households
Households	3 529	Data from detailed UK study used as a basis. Converted to euros and adjusted to take into account relative prices of food in UK compared to the EU as a whole (using Eurostat price level indices).

As the amount of edible food waste is dominated by the household sector, the total cost of food waste in the EU is particularly sensitive to figures used for this sector.

3 Data series from Eurostat used include: apro_acs_a, apri_ap_crpouta, apro_mt_pheadm, apri_ap_anouta, fish_ld07, fish_aq2a.
4 The quantities produced and value per tonne of foods manufactured, processed or prepared into food products are derived from Eurostat Prodcom (DS-066341). The basis for the list of products used is NACE Rev. 2 codes 100111140 through to 110000Z1. The product list of manufactured, processed or prepared food products was then filtered to exclude products not destined for the human food chain e.g. animal feeds, pet foods, items of hides, skin, wool, hair and all other items described as 'unfit for human consumption'. NACE codes with inconsistent and or missing data on either values or quantities were also filtered out.
5 While the gross margin in food retail usually varies between 25 and 30%, the net profit is what remains of the gross margin after all costs have been paid, in developed retail markets, high competition results in the net profit margin of retailers (after tax deductions) rarely exceeding 5%. [Source: FAO Agribusiness Handbook, 2009]

Conversely, the total is much less sensitive to the figures for the other sectors. Therefore the assumptions used are likely to have only a small impact on the overall results. Nevertheless, there is still considerable uncertainty around the estimates of cost. At this stage, they should be used as a rough guide to the total cost of EU food waste and a comparison between sectors.

3.5 Sector specific details

This section provides information on the data received and how it was processed for the five sectors under investigation:

- Primary production
- Processing
- Wholesale & logistics and Retail & markets
- Food Service
- Households

Data from Norway were not used to calculate the average as Norway is not a member of the EU-28. Norway is also not included in the total estimate.[6] In Table 3 in chapter 3.4.1 the number of countries that submitted data is shown.

The quality criteria used for assessing the data provided were:

- Are there extreme values without any explanation of these?
- Are several or major subsectors not being covered?
- Are several or major waste flows not being covered? For example in households, is only source separated food waste being reported?
- Is only the edible waste included in the reported amounts?
- Do the normalized data differ considerably from other data with no identifiable explanation?
- Do the data represent the total amount of waste in waste streams that contained food (e.g. mixed municipal waste), rather than an estimate of just the food waste in those streams. This was a common reason for data provided via the food waste plug-in?
- Are the data unrepresentative of the whole of the country (e.g. it was derived from one region which differs from the rest of the country with respect to waste-related characteristics)?
- Are data based on old studies (e.g. from the 1990s) or data from another country was being used as a proxy (and therefore not directly relevant to the country in question)?

The calculations for each country providing data are shown in Annex F: Country specific tables.

6 Norway however has done many studies on food waste, listed in Appendix G.

3.5.1 Primary production

15 countries supplied data for the sector but only six with sufficient quality of data. The normalized food waste[7] amounts ranged from 7 to 17 kg per tonne of food produced with mean and median values of 10 and 9 kg per tonne respectively.

Each country was asked to provide further information as input in the quality analysis. Information asked concerned to what extent the following elements were included in the reported amounts:

- vegetal (grains etc.)
- animal waste (e.g. dead animals etc.)
- manure and slurries
- by-products
- animal feed
- bio based materials

Clarifications were also requested on how the amounts were distributed between agriculture and fishery and to what extent the reported amounts included postharvest and storage.

Of all the sectors being studied, the primary production sector was the most difficult to quantify. One explanation is that the sector overall has not been studied to the same extent as other sectors. One reason for this is that the sector is very heterogeneous with respect to what products are being produced including for example cattle raising, fishery, cultivation of crops, vineyards, fruits and vegetables. With such a diverse sector and thus a wide range of generated food waste types and amounts, it is very difficult and time consuming to quantify the generated waste amounts with great accuracy. Many wastes will simply be ploughed into the soil or discarded at sea with no quantification or recording taking place. Another explanation is that up until today there has not been any official framework within Europe on how to define food waste. Whether or not a waste should be classified as food waste is considered to be more difficult earlier in the food value chain dealing with rather unprocessed products such as cattle, fishery, crops etc. There is also the aspect of how to classify different waste or losses. Some might be viewed as by-products or feed (and should not be included) in some cases but under different market conditions may be disposed of as waste. Furthermore the definition of the sector could be an aggravating factor which also relates to the food waste definition mentioned above. Another aspect is how to relate to poor quality or loss of products due to heavy rainfalls, pest infestation, diseases etc. which instead of being used for human consumption is discarded or used for other purposes such as animal feed.

Although some clarifications could be made, there are still many uncertainties about what was included and not in the given amounts. Of the 15 countries which had provided food waste data of the sector, six countries had data of sufficient quality to be used in the estimations. The main reasons why data were not included in the estimations were because of:

- extreme values without any explanation of these provided.
- several or major subsectors not being covered.
- several or major waste flows not being covered.

[7] Food waste within the FUSIONS definitional framework includes both "food waste" and "food loss" using the FAO-terms.

Based on this, the estimated uncertainties of ±17% is probably underestimated.

The denominator (produced amount of food) was derived from Eurostat/EC agriculture data for the reference year 2012 (EC 2013; Eurostat 2014, 2015a, b & c). Data[8] were collected for harvested production of cereals, oilseeds, fruit & vegetables, milk, livestock (converted to approximate live weight[9]) and total fishery products (at live weight). The total EU food and fishery production was calculated to be in the region of 830 million tonnes.

Where data on primary production of a particular crop was unavailable for the reference year, data were used from the closest available year. This is not believed to have distorted the actual production significantly in the reference year as complete data sets were available for the major crops and products. However, it is possible that crop failure or non-production could be mistaken for a data gap for some of the minor crops.

3.5.2 Processing

19 countries supplied food waste data for this sector out of which data from four countries were used. The normalized food waste data of sufficient quality ranged from 5-46 kg food waste per tonne of produced food with an average and median value of 22 and 18 kg food waste per tonne of produced food respectively.

The data of each country was analysed to identify any explanations for differences between countries. Each country supplying data was contacted again for clarifications regarding what waste flows were included and if by-products / feed had been included in the amounts. Clarification was also requested regarding by-products (e.g. peel/shell residue and abattoir waste that are made into animal feed) which should not be classified as food waste according to the FUSIONS definitional framework.

The major reasons why data was not included were because of:

- extreme values without any explanation of these provided.
- several or major subsectors not being covered.
- several or major waste flows not being covered.

As with the primary production sector the food processing sector is very heterogeneous in terms of what food products are being produced and thus the type and amounts of food waste being generated. For example, the production of meat products has a totally different food waste profile compared to the production of beverages. Furthermore the types of food processing industries vary between European countries. When estimating the food waste amounts on a European level it has not been possible to consider these differences which have a negative impact on the uncertainties which to some degree explains the high uncertainties.

8 Production data were obtained for cereals, oilseeds, sugar beet, potatoes, carrots, tomatoes, red pepper / capsicum, onions, garlic, brassicas, celeriac, leeks, peas, beans, artichokes, asparagus, spinach, celery, chicory, lettuces, cucumbers, eggplants, courgettes, beetroot, cultivated mushrooms, apples, pears, stone fruit, citrus fruit, melons, watermelons, strawberries, other berries, figs, nuts, vineyards for wine, raisins & table grapes, olives for olive oil & table olives, milk, bovine meat, poultry meat, pig meat, sheep & goat meat, eggs and total fishery products.
9 Carcass weights were converted to live weight using the following live weight to carcass weight factors: 47 % sheep & goats, 70 % pork, 59 % beef and 76 % poultry.

Having no official European framework on how to classify and define food waste also contributes to the uncertainties. This is because in many cases it is difficult to separate food waste from by-products or bio-based material.

In addition to the actual food waste amounts being reported, there are also uncertainties associated with the normalisation factor. The amounts of food products and beverages produced are derived from Eurostat for the reference year 2012 (EUROSTAT 2015e). Data on produced goods were collected by filtering out the amounts for the PRODCOM codes[10] 10XXXXXX and 11XXXXXX which relates to the amounts of goods produced which included food as well as beverages. Data being classified or not specified for a certain product code were not taken into account which contributes to an uncertainty when scaling up the amounts to a European level.

3.5.3 Wholesale and retail

The two sectors were reported separately but analysed together since many countries had difficulties separating them. Structural differences between countries mean that combining wholesale and retail / markets would 'smooth out' some of these differences.

Of the 28 countries, 18 countries supplied food waste amounts for either the wholesale sector or for the retail or for the two sectors as a whole. Of those, four countries only submitted data from the retail sector. To normalise the data, the food waste amounts were divided by the number of inhabitants for each of the countries. The food waste amounts which were considered to be of sufficient quality ranged from 4-30 kg per person with a mean and medium value of 9 respectively 7 kg per person for the retail sector. For the wholesale sector the corresponding values ranged from 0.3-2.0 kg with a mean and medium value of 1kg. The population was based on data from EUROSTAT for the year 2012.

Each country's data were analysed to assess the quality of the data to distinguish any discrepancies in the normalized data. Moreover the respondents supplying the data were once again contacted for clarifications in terms of what subsectors (NACE codes) and what waste flows were included in the figures. Another aspect being regarded was to what extent packaging was included in the figures provided.

Based on the clarifications given, the data were again processed and data of insufficient quality was not considered when estimating the total food waste amounts of the sector on a European level. Based on the provided data and information, it was not possible to apply any fixed quality requirements on whether or not the data should be included in the estimations. Several uncertainties remain in exactly what was included in the amounts given for several countries.

The major reasons why food waste data were not included were because of:

- only the edible waste was included in the reported amounts.
- extreme values without any explanation of these provided.
- several or major subsectors not being covered.
- several or major waste flows not being covered.

10 Prodcom contains Prodcom statistics on production of manufactured goods together with related external trade data. The Prodcom survey is based on the Prodcom List, consisting of about 3900 products. The 8-digit codes used in the List are based on the 6-digit CPA headings and hence the 4-digit NACE rev 1.1. From 2008 onwards the Prodcom code is linked to CPA 2008 and NACE Rev. 2. The link to NACE enables the NSIs to use the Business Register to identify the enterprises likely to be manufacturing the product (Eurostat, 2015f)

As mentioned previously, food waste amounts based on the "food waste plug in" (connected to the Waste Statistics Regulation (WStatR) reported to EUROSTAT were rejected as the level of detail was not sufficient.

3.5.4 Food service

Of the 28 countries, 18 countries supplied data for the food service sector. The received data were normalized by dividing the food waste amounts with the turnover number for the sector which was adjusted by the purchasing power parity (PPP). This was because different countries have different price levels which if not considered will have a negative effect of the quality of the normalised food waste amounts. The turnover number for the sector was based on EUROSTAT data (EUROSTAT 2015g) for 2010 as no later data were available. The normalized food waste amounts were compared for each country and the food waste matrix and the underlying sources of the food waste amounts were analysed. This was to assess the quality of the data and to find any causes of differences in food waste amounts between the countries. Furthermore countries were contacted again to clarify the uncertainties and obscurities of the data supplied. Clarifications concerned which subsectors (schools, restaurants, elderly homes, hotels, prisons etc.) and which waste flows (separately collected food waste, food waste in the residual waste, liquid food waste etc.) were included in the given amounts.

Based on the clarifications, the data were re-analysed and food waste data of insufficient quality were excluded. As it was not possible for the countries to fully clarify what subsectors and food waste streams that were included in the data, it was not possible to apply fixed quality criteria on what food waste data that should be included in the estimations and not. Of the 18 countries submitting data, eight countries were considered to have sufficient quality of the food waste data as a basis to estimate the food waste amounts on a European level. The main reasons why the data were considered to be of insufficient quality were when:

- only the edible waste was included in the reported amounts.
- the normalized data differed considerably from other data and no reasons for it could be identified.
- several or major subsectors were not covered.
- several or major waste flows were not covered.

As mentioned previously, food waste amounts based on the "food waste plug in" (connected to the Waste Statistics Regulation (WStatR) reported to EUROSTAT were rejected as the level of detail was not sufficient.

The normalized food waste amounts of sufficient quality ranged from 10-30 tonnes per million Euros of turnover with a mean and medium value of 20 tonnes per million Euros of turnover respectively.

3.5.5 Households

The household sector had the best coverage of information supplied for this FUSIONS task compared to the other sectors. In all, data were available for 19 EU-28 countries. To give an indication of the spread of results from different countries, for the 11 countries with data for municipal waste streams (combined), these ranges from 44 to

130 kg / person / year, with a mean and median of 71 and 67 kg / person / year respectively.

Those countries supplying data were contacted and asked to clarify details of the flows of (waste) material that were included in the data submitted. For instance, contacts were asked if the information covered:

- food waste in the residual waste stream
- separated food waste collections
- mixed organic waste collections (usually targeting garden and food waste)
- food waste sent to the sewer (mainly drink and liquid foods)
- home composting
- fed to animals (e.g. cats, dogs, chickens, wild birds)

They were also asked to clarify about whether the information covered (edible) food and inedible parts associated with food, or just the edible food component. Correspondence also covered how the estimate had been made, including what methods underpinned the estimate and how representative the information was for the country as a whole.

Information for the estimate of EU-28 household food waste was derived from 11 countries. Reasons for the omission of the data from the other eight countries included:

- Some of the data represented the total amount of waste in waste streams that contained food (e.g. mixed municipal waste), rather than an estimate of just the food waste in those streams.
- Some of the data were not representative of the whole of the country (e.g. it was derived from one region which differs from the rest of the country with respect to waste-related characteristics).
- Some of the data were based on old studies (e.g. from the 1990s) or data from another country was being used as a proxy (and therefore not directly relevant to the country in question).

In addition, when analysing the data it was clear that not all the waste streams described above were covered by all of the remaining 11 countries. See Table 9 for details.

Table 9. Information used in analysis of EU-28 household food waste by material flow.

Waste stream / material flow	Number of countries with data for this waste stream / material flow
Residual waste stream	11
Separated food waste collections or mixed organic waste collections	All where relevant
Sewer	5
Home composting	5
(Fed to animals)	(3)

In discussion with the FUSIONS team, it was agreed that feeding food to animals was outside of the definition of food waste according to the FUSIONS definitional framework, as it is classified as 'valorisation or conversion' activity. This only represents a small fraction of the amount of household waste for those three countries supplying data. It was removed from the estimate of household food waste for the three countries that had supplied it.

This variable coverage of waste streams required calculations that could cope with this complexity. The method used involved estimating the average amount of food waste in each of the following waste streams separately, and then combining the results:

- Municipal waste streams combined (residual waste, separated food waste collections and mixed organic waste collections)
- Food waste sent to the sewer
- Home composting

Data from four countries was available for all three of these waste streams. One additional country had data on municipal waste streams and disposal via the sewer and six further countries had data for municipal waste streams only.

Where a country had an estimate of food waste for a given waste stream, these data were used for that country. These data were then used to for each waste stream to calculate the average amount of food waste per person, by taking the unweighted mean value. To obtain an estimate of food waste for the whole EU-28, the average value per person was applied to the population of those countries without data for that waste stream.

The denominator used was the number of people in the country (population). Estimates of population for the year 2012 were sourced from EUROSTAT. Alternatives were considered – such as the amount of food purchased for consumption in the home – but this information was not readily available.

Alternative methods of scaling up the results to the EU-28 from the data were explored. For example, one method explored involved determining – for each country – the total food waste for all the waste streams and then scaling up the results to cover the whole EU. However, this reduced the number of countries included in the study to four (as most had not supplied data for all waste streams), so this method did not use much of the good data that had been provided. In addition, this made only minor differences to the results.

There is a possibility that scaling up from the countries with robust data to the other EU-28 countries will introduce a bias into the results. The countries with data were largely in the north and west of Europe. They were generally countries with a higher GDP than the EU-28 average. If household food waste is correlated with GDP, then this may have led to a slight over-estimate of food waste from households in the EU-28. It is not possible to quantify this potential bias at this stage, but future studies would benefit from exploring this type of bias.

4 Results

4.1 Combined results

The collation and analysis of data from across Europe for this study generated an estimate of food waste in the EU-28 of 88 million tonnes (Table 10). This estimate is for 2012 and includes both edible food and inedible parts associated with food. This equates to 173 kilograms of food waste per person in the EU-28.

Table 10: Estimates of food waste in EU-28 in 2012 from this quantification study; includes food and inedible parts associated with food.

Sector	Food waste (million tonnes) with 95% CI*	Food waste (kg per person) with 95% CI*
Primary production	9.1 ± 1.5	18 ± 3
Processing	16.9± 12.7	33 ± 25
Wholesale and retail	4.6 ± 1.2	9 ± 2
Food service	10.5 ± 1.5	21 ± 3
Households	46.5 ±4.4	92 ± 9
Total food waste	**87.6 ± 13.7**	**173 ± 27**

**Confidence interval*

The sectors contributing the most to food waste are households (47 million tonnes ± 4 million tonnes) and the processing sector (17 million tonnes ± 13 million tonnes). These two sectors account for 72% of EU food waste, although there is considerable uncertainty around the estimate for the processing sector. In addition and as previously mentioned the uncertainties for the production sector is probably underestimated in the table. Of the remaining 28 percent of food waste, 11 million tonnes (12%) comes from food service, 9 million tonnes (10%) comes from production and 5 million tonnes (5%) comes from wholesale and retail.

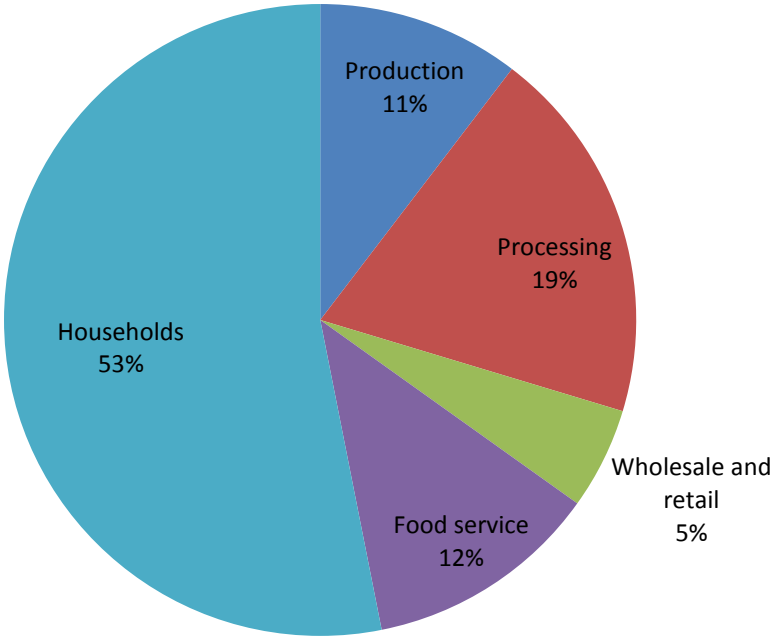


Figure 3: Split of EU-28 food waste in 2012 by sector; includes food and inedible parts associated with food.

There is moderately high uncertainty around this estimate; the approximate 95% confidence interval is ±14 million tonnes (or ±16%). Therefore, the range of results within this confidence interval is from 74 million tonnes to 101 million tonnes.

The level of uncertainty seen in the results is due to only a small number of recent studies of sufficiently high quality being identified. Data were only obtained for up to a quarter of MS (the exact figure depending on the sector) and the process of scaling the information from these MS to the whole EU-28 is responsible for this relatively large uncertainty. In addition, there was a bias in the MS reporting data towards larger countries and those in the North and West of the continent. This introduces further uncertainty, as these countries supplying data may not be fully representative of the rest of the EU-28. It is very difficult to quantify this type of uncertainty without further research.

Therefore, a key recommendation from this exercise for accurately quantifying food waste in Europe is to increase the number of EU MS that measure food waste robustly. This will be necessary if there is an EU food waste target that requires monitoring. This recommendation applies to all sectors; however, the lack of data was particularly acute for the primary production sector – there are very few measurements of waste in agriculture, horticulture, aquaculture, fisheries or other primary production activities.

This can be achieved by ensuring that those studies that do take place use a consistent definition of food waste (taken from the FUSIONS definitional framework), have robust sampling procedures in place, and use measurement methods that are accurate. More details to assist MS in achieving this will be given in the FUSIONS food waste quantification manual. It can also be facilitated by ensuring that adequate funding is available for future food waste studies.

For each sector the value used for upscaling is presented below. This can be used for national calculations using national figures for the normalisation factors. However, it should be noted that it will only give a rough estimate with the uncertainties described below for each sector.

4.2 Primary production

For the primary production sector, the total amount of food waste was estimated to be 9 million tonnes (± 2 million tonnes) in 2012. This corresponds to 18 kilograms per person per year (± 3 kg / person / yr). Based on the normalisation factor used, the food waste amounts to 10 kg for every tonne of food being produced on average. This is equivalent to a food waste[11] of 1 percent. The estimates include both (edible) food and inedible parts associated with food.

Of all sectors studied, the primary production sector was the most difficult to analyse and quantify. One major reason for this is the diversity of the sector, a sector which furthermore has not been studied in detail for most countries supplying data, for example fisheries is not totally covered. The uncertainties which are considered as under estimated associated with these estimates are discussed in full in section 3.5.1.

4.3 Processing

For the processing sector, the total amount of food waste was estimated to be 17 million tonnes (± 13 million tonnes) in 2012. This corresponds to 33 kilograms per person per year (± 25 kg / person / yr). The figures correspond to an average of 22 kg of food waste for every tonne of food produced which is equivalent to a food loss of about 2 percent. The estimates include both (edible) food and inedible parts associated with food. It is important to reiterate that by-products destined for animal feed and bio-based products are not included in this figure.

The food waste amounts for this sector are based on only four countries which is one explanation of the rather high uncertainty. Another contributing factor in the uncertainty is that the sector is much diversified in terms of food and thus food waste being produced which also differs between different countries. For more information about the uncertainties about the food waste amounts see section 3.5.2.

4.4 Wholesale and retail

For the combined wholesale, retail & markets sector, the total food waste amounted to 4.6 million tonnes (± 1 million tonnes) in 2012. This is equivalent to 9 kilograms per person per year (± 2 kg / person / yr). The amounts include the edible as well as the inedible parts associated with food.

[11] In the FUSIONS definitional framework both food waste and food loss are included in the term food waste

For this sector there were data from 11 countries which were used to extrapolate the amounts to a European level which is one reason for the uncertainty of the figures. For more information about the uncertainties about the food waste amounts see section 3.5.3.

4.5 Food Service

The food service sector generated almost 11 million tonnes (± 2 million tonnes) of food waste in the EU-28 during 2012. This corresponds to 21 kilograms per person per year (± 3 kg / person / yr). Based on the normalisation factor used, the amounts are equivalent to 20 tonnes of food waste for every million Euro in turnover number (PPP adjusted). The amounts include the total food waste, that is both the edible and the inedible food waste are included.

The small number of countries (eight) supplying food waste data of good enough quality is the main reason of the high uncertainties for the sector, see sector 3.5.4 for more detailed information about the uncertainties.

4.6 Household

There was an estimated 47 million tonnes (± 4 million tonnes) of household food waste in the EU-28 in 2012 (Table 11). This is equivalent to 92 kilograms per person per year (± 9 kg / person / yr). These estimates include both (edible) food and inedible parts associated with food.

Table 11: Estimates of household food waste in the EU-28 split by waste stream (2012 estimate)

Sector	Household food waste			
	Total (tonnes)	Approximate 95% CI	Per person (kg / year)	Approximate 95% CI
Municipal waste streams*	35 000 000		69.2	
Sewer (mostly liquid)	7 800 000		15.4	
Home composting	3 800 000		7.4	
Total	**46 600 000**	**±4 400 000**	**91.0**	**±8.8**

* includes food waste in residual, separate food waste collections, mixed organics collections

Around three quarters of this total is collected from households by (or on behalf of) municipalities, a total of 35 million tonnes (Figure 4). The remainder either goes down the sewer (8 million tonnes) or is home composted (4 million tonnes).

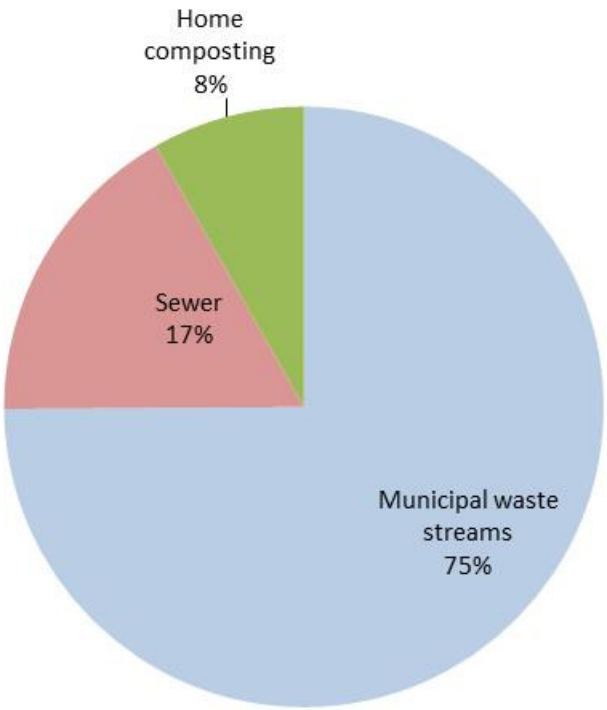


Figure 4: Relative contribution to household food waste in the EU-28 from different material flows

These estimates exclude material being fed to animals (e.g. pets, wild birds) as this material is considered to stay within the food system. For countries that did supply data, this material flow is very small compared to the total food waste presented above.

It should be noted that this estimate is based on data from eleven EU MS, with an extrapolation from these to give a total figure. This explains the relatively high levels of uncertainties associated with these estimates (although these are smaller in percentage terms than for most other sectors). The uncertainties associated with these estimates are discussed in full in section 3.5.5.

4.7 Food redistribution

Food that is redistributed is not accounted for as food waste. However since it is an action taken to prevent food waste from being generated it is worth recording. Redistribution is an activity with many operating models - it is commonly observed with so called food banks being the conduit between the donor and the recipients. It is also common with more direct redistribution between a local store and a charity.

For food redistribution very little data are known. However a few countries have undertaken studies and these are shown in Table 12:

Table 12: Data on food redistribution in EU-28.

Country / region	Amount (tonnes)	Year	Source
EU	411 000	2014	The European federation of foodbanks (FEBA)
Austria	11 100	2014	Pladerer et al. (2015)
Nordics	900	2013	Hanssen et al. (2014)
UK	20 000	2014	WRAP 2015
Netherlands	20 000	2013	Bos-Brouwers et al (2015)

The European federation of foodbanks (FEBA) estimates that 411 000 tonnes of food was redistributed in 2014 (www.eurofoodbank.eu) via their members. This is based on what members report. The number is likely to be underestimated since not all redistribution is happening via food banks. It should also be acknowledged that it is only an estimate covering their members and not non-member foodbanks or other initiatives across Europe.

The Austrian study is based on interviews and questionnaires sent out to different actors. Given that it is hard to estimate amounts without using proper weighing, the results should be handled with care.

The Nordic data (Hanssen et. al 2014) are based on data from the registered food banks. During the project it became clear that there is a large amount of food being redistributed without the organisation of a food bank, hence the number is low. Even having considered the alternative distribution channels, it remains clear that the amounts redistributed in the Nordic region are low compared to other European countries.

The UK number is calculated from an estimate based on what the signatories report and sense-checked against reported volumes from commercial and charitable redistributors. (Second year results from the Courtauld Commitment, WRAP 2015).

The data from the Netherlands are calculated based on the number of food packages redistributed and the average weight of those packages. The number of packages redistributed was obtained from the Dutch food banks.

The studies presented here are not a complete list of studies and there might be other estimates available.

4.8 Animal feed

Food being used as feed for animals is not accounted for as food waste according to the FUSIONS definition. However it might vary over time what streams are sent to feed or waste treatment and it is recommended also to keep track of these waste streams in order to get a better total picture of the flows.

Existing studies shows that the valorisation of food waste in this way is a common approach and preferred by many sectors rather than sending it to waste treatment since it avoids gate fees for disposal and may generate a financial return. The proportion utilised as animal feed can be as high as 50-80% of the total discard (INRA 2015). In general, the boundaries between food waste, by-products and production waste are hard

to draw and this will have an effect on the amounts of food waste reported as going to feed in different studies. Hence the figures are only to be seen as indicative. Also worth noting is that by-products also to some extent are used in feed production.

In Table 13, some studies are listed to give a picture of the current flows - this list is not a complete list and other studies might be available. The numbers shown must of course be considered in relation to the total amounts of food produced.

Table 13 Data on food and by-products utilised as feed in the EU-28.

Country	Amount (tonnes)	Year	Source
EU	5 000 000	2015	European Former Foodstuff Processors Association (EFFPA)
UK	450 000	2011	Whitehead et al. 2011
France	1 682 000	2016	Redlingshöfer et al 2015b

The European Former Foodstuff Processors Association (EFFPA) claims that 5 million tonnes of former food stuff is used as animal feed (http://www.effpa.eu/figures-network/). They also claim that this can increase to 7 million tonnes until 2025.

The UK figure for 2011, 450 000 tonnes, is based on numbers given by FDF (Food and Drink Federation) combined with a survey among animal feed manufacturers. Other UK studies are also available, and the UK Former Foodstuffs Processing Association report that 650,000 tonnes of food surplus (i.e. food that might have become waste) are now converted in to animal feed in the UK, consisting with a significant increase between 2011 and 2015/16.

In France, Redlingshöfer et al (2015b) made an estimation based on the most common sectors to deliver to feed production (bakeries, slaughter houses and dairy production). This is to be seen as an estimate and a lowest number. For some production, like wheat, it is not possible to say what was intended for human consumption from the beginning, so making the classification of food waste impossible. The same situation will also occur in other production sectors and other countries.

In Sweden, data on feed have been registered during the work with food waste statistics (work in progress). The study based on the environmental reports sent in by the companies shows that the amounts going to feed well exceeds the amounts being wasted. The most common streams used as feed are "milk residues" (milk from flushing the pipes as well as milk sent back from stores etc.) and slaughter wastes.

4.9 Costs

The costs associated with food waste for EU-28 in 2012 are estimated at around 143 billion euros. Two-thirds of the cost is associated with food waste from households (around 98 billion euros, figure 5). This is due to this sector a) having more edible food waste than any other sector and b) the costs associated with a tonne of food accumulating along the supply chain (e.g. processing, packaging, retailing costs).

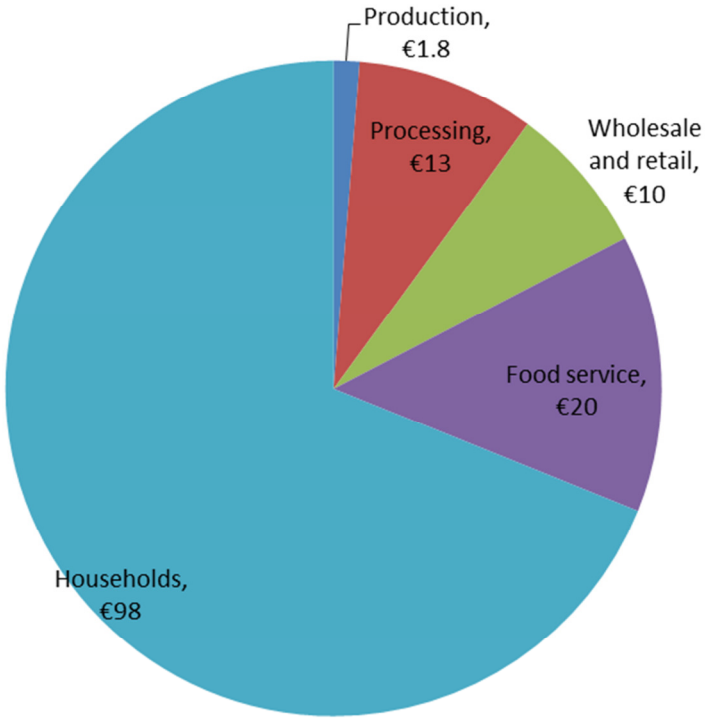


Figure 5. Costs associated with food waste by sector (values in billions of euros)

The costs relate to the value of the food that has been wasted within the given sector. As an example, for household food waste, this is the retail value of the food thrown away. The estimate only covers the edible food that is wasted – the estimate does not cover the value of inedible parts associated with food (which is much lower than the edible fraction).

Further details on the calculations can be found in section 3.4.4. There is considerable uncertainty around the estimates of cost. At this stage, they should be used as a rough guide to the total cost of EU food waste and a comparison between sectors.

4.10 Overview of other studies

Data have not been previously compiled in this way with this definition. Comparing with data from other studies is challenging since the boundaries and definitions used are different. In this study both liquid waste from households and waste from the primary production are included.

The previous estimate of EU food waste of 89 million tonnes obtained by Bio Intelligence service (2010) is within the range of the food waste estimates from this study. However in the Bio Intelligence service study, the primary production or liquid food waste was not included. Also Croatia joined the EU on 1 July 2013 as the 28th MS so their data are not included in the Bio Intelligence service study. On the other hand amounts that should not be accounted for as food waste according to the FUSIONS definition are included in the Bio Intelligence Ser study. Given the differences in methodology and foremost the definition this cannot be used neither for validating this study or to prove it wrong. However the fact that the amounts are within the same range indicates that the results of the two studies are trustworthy.

The report published by JRC (Vanham et al 2015) calculates the amounts of food waste based on food that reaches the consumer (FAO figures) and waste factors for different product categories based on reports from six member states. The reports used are not always the newest data available for that country. The results are in line with the FUSIONS data set but given the differences in methodology this cannot be used as a validation of the results. The benefit in the JRC study is the possibility to calculate food waste for different food categories.

Gustavsson et al (2011) is also using the produced food amounts and calculated waste factors to calculate food waste. The amounts generated from the different sectors follow the results in FUSIONS showing that households are wasting the most.

The 'food waste plug-in' project was set up by Eurostat to see if data on food waste could be obtained based on the existing data collection according to the Waste Statistics Regulation (WStatR). In the 'plug-in', data were reported based on the List of Waste codes (LoW codes) that might contain food waste. The fact that the amounts reported also contain other waste apart from food waste makes the data not feasible for the use of FUSIONS. The results can thus give an indication on the amounts of food waste generated in MS.

5 References

Avfall Sverige (2014), Svensk avfallshantering 2014, Avfall Sverige

Baptista P., Campos I., Pires I., Vaz S., (2012), Do campo ao garfo desperdicio alimentar em Portugal

Bio Intelligence Service (2010). Preparatory study on food waste across EU 27. European Commission.

Bos-Brouwers H, Soethoudt H, Vollebregt M, van der Burgh M (2015), Monitor voedselverspilling – Update Monitor voedselverspilling 2009-2013 & Mogelijkheden tot (zelf)monitoring van voedselverspilling door de keten heen, Food & Biobased Research nummer 1541, ISBN 978-94-6257-400-7

CONCITO (2011). The Hidden Food Waste (Det Skjulte Madspild). Danish Ministry of Food, (in Danish)

De Waart (2011). Voedselverspilling 062. (in Duth). Milieu Centraal.

Environmental Protection Agency Denmark (2014a), Undgå affald, stop spild nr. 5, Kortlægning af madaffald I servicesektoren

Environmental Protection Agency Denmark (2014b), Undgå affald, stop spild nr. 1, Kortlægning af dagrenovation i Danmark

Environmental Protection Agency Ireland (2015), National Waste Statistics - Reports and Bulletins. Avaliable at: http://www.epa.ie/pubs/reports/waste/stats/#.VsRm2_krLBQ

EPSILON SA, Ecosfairiki-Mandilas Christoforos, DELPHI ENGINEERING (2014). National Waste Management Plan. (in Greek). Ministry of Environment Energy and Climate Change.

European Commission, Agriculture in the European Union. Statistical and Economic Information. Report 2013, December 2013, Table 4.19.1.1

European Federation of Foodbanks http://www.eurofoodbank.eu/

EUROSTAT (2014), Fishery production in all fishing regions (tag00117), available at http://ec.europa.eu/eurostat/data/database

EUROSTAT (2015a), Production and utilization of milk on the farm - annual data (apro_mk_farm), available at http://ec.europa.eu/eurostat/web/agriculture/data/database

EUROSTAT (2015b), Slaughtering in slaughterhouses – annual data (apro_mt_pann), available at http://ec.europa.eu/eurostat/web/agriculture/data/database

EUROSTAT (2015c), Crop products – annual data (apro_cpp_crop), available at http://ec.europa.eu/eurostat/web/agriculture/data/database

EUROSTAT (2015e), Industry, trade and services, available at http://ec.europa.eu/eurostat/data/database

EUROSTAT (2015f), Statistics on the production of manufactured goods, available at http://ec.europa.eu/eurostat/cache/metadata/en/prom_esms.htm

EUROSTAT (2015g), Accommodation and food service statistics - NACE Rev. 2, available at http://ec.europa.eu/eurostat/data/database

FAO - http://faostat3.fao.org/download/FB/FBS/E

Food waste plug-in Austria (2012), Reported to Eurostat for the year 2012

Food waste plug-in Belgium (2012), Reported to Eurostat for the year 2012

Food waste plug-in Croatia (2012), Reported to Eurostat for the year 2012

Food waste plug-in Lithuania (2012), Reported to Eurostat for the year 2012

Food waste plug-in Luxembourg (2012), Reported to Eurostat for the year 2012

Food waste plug-in Malta (2012), Reported to Eurostat for the year 2012

Food waste plug-in Slovakia (2012), Reported to Eurostat for the year 2012

Garrone P., Melacini M., Perego A., (2012) Dar da mangiare agli affamati: le eccedenze alimentari come opportunità. Executive summary, Politecnico di Milano.

Garrone P., Melacini M., Perego A (2014), Opening the black box of food waste reduction, Food Policy 46 (2014) 129 -139.

Gustavsson J., Cederberg C., Sonesson U., van Otterdijk R. & Meybeck A. (2011) Global Food Losses and Food Waste: Extent, Causes and Prevention, Rome: Food and Agriculture Organisation of the United Nations.

Hanssen O.J., Schakenda V. (2011), Nyttbart matsvinn i Norge 2011, Ostfoldforskning, OR.27.11

Hanssen O.J.,Skogesal O., Møller H., Vinju E., Syversen F. (2013), Kunnskap om matsvinn fra norske husholdninger, Ostfoldforskning, OR.38.13

Hanssen O.J., Ekegren P., Gram-Hanssen I., Korpela P., Langevad-Clifforth N., Skov-Olsen K., Silvennoinen K., Stare M., Stenmarck Å., Svanes E. (2014), Food redistribution in the Nordic countries, Tema Nord 2014:562

HSY Helsinki Region Environmental Services Authority (2012). Quality and quantity of households mixed solid waste in the Helsinki metropolitan area 2012. HSY Publications 2/2013. 44p

ISWA University of Suttgart (2012). Ermittlung der weggeworfenen Lebensmittelmengen und Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland. BMEL.

Jansen (2007). Fresh on demand - Een afstudeeropdracht naar de derving in de horeca. (in Dutch).

Katajajuuri J.-M., Silvennoinen K., Hartikainen H., Heikkilä L., Reinikainen A. (2014). Food waste in the Finnish food chain. *Journal of Cleaner Production*, Volume 73, 15 June 2014, Pages 322-329, ISSN 0959-6526, http://dx.doi.org/10.1016/j.jclepro.2013.12.057.

Le Bolloch Odile, Irish Environmental Protection Agency, Personal communication 2016.

Lebersorger S. and Schneider, F. (2014); Aufkommen an Lebensmittelverderb. ECR Austria – Efficient Consumer Response & ABF-BOKU, Wien.

Lithuanian waste statistics (2015)

Luxembourgh waste statistics (2015)

Ministry of Environment Energy and Climate Change of Greece (2012). Implementation Guide of Source Sorting Programme and Biowaste Management Systems. (in Greek). Ministry of Environment Energy and Climate Change.

Moora H., Urbel-Piirsalu E., Viilvere T. (2015), Toidujäätmete teke Eesti kaubandus- ja toiduainetööstusettevõtetes, Stockholm Envionment Institute

Møller H., Hanssen O.J., Svanes E., Hartikainen H., Silvennoinen K., Gustavsson J., Östergren K., Schneider F., Soethoudt H., Canali M., Politano A., Gaiani S., Redlingshöfer B., Moates G., Waldron K., Stenmarck Å. (2014a). Standard approach on quantitative techniques to be used to estimate food waste levels. Report from FUSIONS project.ISBN: 82-7520-723-1; 978-82-7520-723-2

Møller H., Hanssen O.J., Gustavsson J., Östergren K., Stenmarck Å. (2014b) Report on review of (food) waste reporting methodology and practice. Report from FUSIONS project ISBN 82-7520-713-4 978-82-7520-713-3

Pladerer, Ch. et al. (2015): Lebensmittelweitergabe in Österreich: Ein aktiver Beitrag zur Abfallvermeid

Priefer C.. Jörissen J., Bräutigam K.-R. (2013). Technology options for feeding 10 billion people. Options for cutting food waste - Final report. European Parliament.

Redlingshöfer B., 2015a. La méthodologie utilisée dans l'étude INRA pour l'analyse des pertes alimentaires dans les filières. Innovations Agronomiques 48 (2015), 11-22

Redlingshöfer B., Coudurier B., Georget M., 2015b. Etat des lieux et leviers pour réduire les pertes alimentaires dans les filières françaises. Innovations Agronomiques 48, xx-xx

Schneider F., Part F., Lebersorger S., Scherhaufer S., Böhm K. (2012). Sekundärstudie Lebensmittelabfälle in Österreich. (in German). Austrian Ministry of Environment.

Segrè A., Falasconi L. (2011). Il libro nero dello spreco in Italia: il cibo. (in Italian). Edizioni Ambiente.

Stare M., Johansson M., Dunsö O., Stenmarck Å., Sörme L., Jensen C. (2013). Förbättrade matavfalls-faktorer för verksamheter. SMED (Svenska MiljöEmissionsData), (in Swedish), Rapport Nr 2013:117.

Stenmarck Å., Hanssen O-J., Silvennoinen, K. Katajajuur J-M. Werge M. (2012), Initiatives on prevention of food waste in the retail and wholesale trades, Tema Nord

Swedish Board of Agriculture (2016). Nordic Project on Reduced Food Waste- Sub-project 1, Definitions, system boundaries and methodology, Data collection in primary production. Swedish Board of Agriculture.

Swedish EPA (2014). Food Waste quantities in Sweden 2012. Swedish EPA.

Scherhaufer S., Lebersorger S., Pertl A., Obersteiner G., Schneider F., Falasconi L., De Menna F., Vittuari M., Hartikainen H., Katajajuuri J. M., Joensuu K., Timonen K., van der Sluis A., Bos-Brouwers H., Moates G., Waldron K., Mhlanga N., Bucatariu C. A., Lee W. T. K., James K., Easteal S. (2015). Criteria for and baseline assessment of environmental and socio-economic impacts of food waste. Report from FUSIONS project.

Silvennoinen K,, Katajajuuri J,-M., Hartikainen H., Jalkanen L., Koivupuro H.-K., Reinikainen A. (2012). Food waste volume and composition in the Finnish supply chain : special focus on food service sector. CISA Publisher.

Silvennoinen K., Korhonen O. (2013). Food waste volume and composition in Helsinki region households. *Proceedings of the 6th international conference on life cycle management.* 25–28 August 2013, Gothenburg, Sweden.

Silvennoinen K., Pinolehto M., Korhonen O., Riipi I., Katajajuuri J.-M. (2013). Kauppakassista kaatopaikalle, ruokahävikki kotitalouksissa : Kuru 2011–2013 -hankkeen loppuraportti. (in Finnish). MTT, 31600 Jokioinen

Slovenian waste statistics (2015)

Sörme L., Johansson M., Stare M., Mängd mat och dryck via avloppet-en enkätundersökning i svenska hushåll (2014), Livsmedelsverket, report 6624

Vanham D., Bouraoui F., Leip A., Grizzetti B., Bidoglio G. (2015), Lost water and nitrogen resources due to EU consumer food waste, Environ Res Lett 10 (2015) 084008

Van Westerhoven & Steenhuisen (2010), Bepaling voedselverliezen bij huishoudens en bedrijfscatering in Nederland http://www.rwsleefomgeving.nl/publish/pages/92265/eindrapport_in_kaart_brengen_voedselverliezen_huishoudens_en_catering__crem_sept_2010_.pdf

Whitehead P, Parfitt J, Bojczuk K, James K (2011), Estimates of waste in the food and drink supply chain, http://www.wrap.org.uk/sites/files/wrap/Estimates%20of%20waste%20in%20the%20food%20and%20drink%20supply%20chain_0.pdf

Waste Watcher (2013). Observatory on Italian household food waste. Rapporto 2013, LMM (in Italian).

WRAP 2013a, Estimates of waste in the food and drink supply chain. WRAP.

WRAP 2013b, Overview of Waste in the UK Hospitality and Food Service Sector.

WRAP 2013c, Household Food and Drink Waste in the UK 2012. WRAP.

WRAP 2015, Second year results from the Courtauld Commitment (in progress)

WRAP 2015b, Handy facts and figures on waste in the UK, http://www.wrap.org.uk/content/uk-handy-waste-facts-and-figures-retail-sector

Östergren K., Gustavsson J., Bos-Brouwers H., Timmermans T., Hanssen O. J., Møller H., Anderson G., O'Connor C., Soethoudt H., Quested T., Easteal S., Politano A., Bellettato C., Canali M., Falasconi L., Gaiani S., Vittuari M., Schneider F., Moates G., Redlinghöfer B. (2014). Main definitional choices for the food and drink waste produced within Europe. Report from FUSIONS project.

Annex A: Matrix-Generated amounts of food waste

Country: XXX													
Provider of data:	Name:	XX		Title:	XX	Organisation:	XX		E-mail:	XX		Telephone:	XX
Part of Food Supply Chain	**Category of food waste**	**Is data on amounts available?**	**Amount (tons/year)**	**Specify the used definition and content of the food waste category**	**Share of liquid waste**	**Estimated degree of uncertainty**	**Methods for quantifying food wastage**			**Source**	**Year that data represent**	**Coverage of the data**	**Comments and details**
							Data measuring	**Data collection**	**Up-scaling**				
1. Production (NACE 1-3)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
2. Processing (NACE 10-11)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
3. Wholesale and logistics (NACE 46)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
4. Retail and markets (NACE 47)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
5. Redistribution (food donation etc.)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
6. Food service, total (NACE 56)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
6.1 of which Hotels (NACE 55)	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
6.2 of which Restaurants	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
6.3 of which Catering/canteens	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												
7. Household	**Total food waste**												
	Edible food products/substances												
	Inedible food parts												

Annex B: Matrix-The destinations for this food waste

Provider of data:	Name:	XX			Title:	XX								Organisation:	XX							
Part of Food Supply Chain	Category of food waste	Is data on treatment available?	Amount (tons/year)	Specify the used definition and content of the food waste category	Share of liquid waste	Method of treatment																Autosum of the treatment
						Charity Redistribution		Animal feed		Anaerobic digestion		Composting		Home composting		Treatment at wastewater treatment plant		Incineration with energy recovery		Landfilling		Other/ Unknown	
						Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	Estimated degree of Uncertainty	Share of total amount to all treatment/ disposal methods	
1. Production (NACE 1-3)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
2. Processing NACE 10-11)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
3. Wholesale and logistics (NACE 46)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
4. Retail and markets (NACE 47)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
5. Redistribution (food donation etc.)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
6. Food service (total) (NACE 56)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
6.1 of which Hotels (NACE 55)	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
6.2 of which Restaurants	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
6.3 of which Catering/canteens	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%
7. Household	Total food waste		0																			0%
	Edible food products/substances		0																			0%
	Inedible food parts		0																			0%
	Liquid food waste																					0%

cont. Annex B: Matrix-The destinations for this food waste

Part of Food Supply Chain	Category of food waste	Estimated degree of Uncertainty	Methods for quantifying the treatment of the food waste			Source	Year that data represent	Coverage of the data	Comments and details
			Data measuring	Data collection	Up-scaling				
1. Production (NACE 1-3)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
2. Processing (NACE 10-11)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
3. Wholesale and logistics (NACE 46)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
4. Retail and markets (NACE 47)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
5. Redistribution (food donation etc.)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
6. Food service (total) (NACE 56)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
6.1 of which Hotels (NACE 55)	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
6.2 of which Restaurants	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
6.3 of which Catering/canteens	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								
7. Household	Total food waste								
	Edible food products/substances								
	Inedible food parts								
	Liquid food waste								

Annex C: Matrix-The amount of food waste split into different product categories

Provider of data:	Name:	XX			Title:	XX					Organisation:	XX								E-mail:
Part of Food Supply Chain	Category of food waste	Is data on food types available?	Amounts (tons/year)	Specify the used definition and content of the food waste category	Share of liquid waste	Share of food products (according to the FAO classification) If available data has another classification/aggregation and it is difficult to convert it into the 16 types in the file, please provide the project group with existing data in another form and FUSIONS will use that as a basis for further analysis.														Autosum of the food products
						01. Dairy products	02. Fats and oils, oil based products	03. Ice cream, sorbets etc.	04. Fruits and vegetables, including nuts and seeds	05. Confec-tionary	06. Cereals and cereal products	07. Bakery wares	08. Meat and meat products, incl. game	09. Fish and fish products, including molluscs and crustaceans	10. Eggs and egg products	11. Sweeteners, incl honey	12. Salt, spices, soups etc	13. Food stuff	14. Beverages, excl. dairy products	15. Ready to eat food	16. Composite food not possible to include in other groups	
1. Production (NACE 01-03)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
2. Processing (NACE 10-11)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
3. Wholesale and logistics (NACE 46)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
4. Retail and markets (NACE 47)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
5. Redistribution (food donation etc.)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
6. Food service (total) (NACE 56)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
6.1 of which Hotels (NACE 55)	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
6.2 of which restaurants	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
6.3 of which Catering/canteens	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			
7. Household	Total food waste		0																	
	Edible food products/substances		0																	
	Inedible food parts		0																	
	Liquid food waste																			

cont. Annex C: The amount of food waste split into different product categories

Part of Food Supply Chain	Category of food waste	Estimated degree of Uncertainty	Methods for quantifying the food waste products		Source	Year that data represent	Coverage of the data	Comments and details
			Data measuring	Data collection				
1. Production (NACE 01-03)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
2. Processing (NACE 10-11)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
3. Wholesale and logistics (NACE 46)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
4. Retail and markets (NACE 47)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
5. Redistribution (food donation etc.)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
6. Food service (total) (NACE 56)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
6.1 of which Hotels (NACE 55)	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
6.2 of which Restaurants	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
6.3 of which Catering/canteens	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							
7. Household	Total food waste							
	Edible food products/substances							
	Inedible food parts							
	Liquid food waste							

Annex D: Instructions for collection of national food waste data

Collection of national food waste data

EU-28

Reducing food waste through social innovation
FUSIONS EU project is supported by the European Community's Seventh Framework Programme under Grant Agreement no. 311972.

Contents

1. Introduction

FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) is a project aiming at achieving a more resource efficient Europe by reducing food waste (http://www.eu-fusions.org/). The project is funded by the European Commission framework programme 7, has 21 project partners from 13 countries and runs from 2012 to 2016.

One of the goals of FUSIONS is to contribute towards the harmonisation of food waste monitoring. The project can make a significant contribution to improve the basis for collecting data on food waste on a voluntary basis, alongside the formal requirement in the present EU statistics. As a part of this work FUSIONS needs help from national representatives with National food waste data which are more detailed than the data reported to EUROSTAT[12].

IVL Swedish Environmental Research Institute is the FUSIONS-partner responsible for collection and elaboration of the national data. The data will be handled by IVL with assistance from the FUSIONS partners BIOIS, SIK, Østfoldforskning, BOKU, UNIBO, DLO and IFR[13]. The collected dataset will be an official delivery to EU. Please, let us know if you provide us with sensitive or confidential data and we will handle it accordingly. The objective of the collection is principally to get a baseline of the European situation of food waste and not to present data on individual studies. The first results will be published in a report available at FUSIONS homepage in the beginning of 2015.

Contact information for questions and submission of national data
Please contact Carl Jensen carl.jensen@ivl.se or Åsa Stenmarck asa.stenmarck@ivl.se at IVL Swedish Environmental Research Institute if questions arise. The completed table can be e-mailed to Carl Jensen or Åsa Stenmarck before **2014-05-30**.

[12] Eurostat (http://epp.eurostat.ec.europa.eu) is the statistical office of the European Union situated in Luxembourg. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.
[13] IVL Swedish Environmental Research Institute (SE), BIOIS - BIO Intelligence Service (FR), SIK - The Swedish Institute for Food and Biotechnology (SE), Østfoldforskning (NO), BOKU - Universität für Bodenkultur Wien (AT), UNIBO - University of Bologna (IT), DLO -Wageningen University (NL), IFR - Institute for Food Research (GB)

2. General information about the National food waste data collection

2.1 Is the food waste data provided to EUROSTAT not enough?

EUROSTAT is already collecting data on the amount of waste from the MS. Yet, the method of collecting data on food waste is not sufficient as the reported waste codes include several types of organic waste besides food waste. Currently the EUROSTAT data on food waste is undergoing an improvement as the plug-in initiative was launched in 2012. This means that the EU-data from 2012 will be more detailed compared to the data from 2010. Even with the plug-in initiative the existing data on the European level is not sufficient to be of use for the follow-up of the work of minimizing food waste. There is a need of more precise data on the actual food waste in the EU.

Often the national representatives have more detailed data than what is required by EUROSTAT. This is why FUSIONS is asking national representatives for further data. FUSIONS have contact with EUROSTAT and access to their official statistics. The data from the two sources will be compared and analysed by FUSIONS.

2.2 What kind of national estimates of amounts of food waste is available in your country?

As mentioned above, the national statistical offices may have more detailed data than the data provided to EUROSTAT. If there are no such data from the statistical office other studies or reports regarding food waste can be used to fill in the national food waste data file.

The data we ask for needs to represent the national level. If national data is available, please explain in the excel-sheet which method was used to get the data and which method of extrapolation was used. However, if there are no studies for the national level, existing studies representing a lower level can be used if the data are extrapolated to the national level before filling in the file. In this case, FUSIONS ask the national representative to carry out the necessary calculations and estimations to transform the primary data from the case-study so that it represents the national level. An explanation of the method used by the national representative to extrapolate the data should either be provided in the food waste table or sent to FUSIONS in another form.

2.3 What will FUSIONS do with the collected data?

As the work to minimize food waste is receiving increased attention throughout society it is important to map the situation and to be able to follow the trends in generation of food waste. FUSIONS is trying to gather national information on available food waste data and on the food waste amounts to get a baseline of data that will show the present situation on amounts, treatment and division of food products in the food waste. The provided data, together with the EUROSTAT quality reports, will be used to make the baseline of data for the EU-28.

The scope of this survey is also to map what kind of data are available and what is missing. The methods that have been used are of interest. The result of the analysis of this survey will be used for several purposes; to raise awareness, to enable setting targets and track progress in food waste prevention and to gather information to produce guidelines for how to measure food waste.

2.4 The FUSIONS definitions

The work with a FUSIONS definition of food waste is on its way. In this document the following is meant:

Food – Food means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be eaten by humans. Food includes drinks, chewing gum and any substance, including water, intentionally incorporated into food during its manufacture, preparation or treatment.

Food Supply Chain – The food supply chain is defined as the connected series of activities used to produce, process, distribute and consume food.

Total food waste – Any food and inedible parts removed from the food supply chain. It is the sum of "edible parts" and "inedible parts" which allows for monitoring the wasted resources from the food supply chain at the lowest level of detail. Generally data are most frequently available on the total food waste fraction and this category is interesting when trying to optimise waste treatment methods and resource efficiency.

Edible food products or substances – Food that has or had the potential to be eaten removed from the food supply chain. This category of edible parts needs to be monitored to follow up the effects of measures aiming to prevent food wastage.

Inedible parts – Inedible parts (bones, peels etc.) removed from the food supply chain. Example: FUSIONS definition of food waste is food that leaves the food supply chain, i.e. food that goes to waste management, down the drain or to animal feed. This means that food that is transferred from one part of the chain to another and still used for human consumption is not considered food waste in this sense.

3. Information about the National food waste data file

In this chapter the overall structure of the sheets is explained. More specific information of how to compile the sheets is found in chapter 4, 5 and 6.
Rows where there is no available data can be left blank and thus the whole sheets will not be completely filled.

3.1 Three sheets of data collection

FUSIONS has divided the collection of desired food waste data into three sheets:

1. Generated amounts of food waste (tons/year)
2. Treatment of generated food waste (%)
3. Type of food waste products (%)

The main structure of the sheets is the same. All the sheets contain cells regarding estimated degree of uncertainty, method, source, year and coverage. This is to enable the FUSIONS-team to analyse the data when estimating the total food waste data set for the whole EU. The references used can be listed in the sheet called "references". Comments can be written in the last column of the three sheets as well as in a sheet called "Additional data". Several of the cells have dropdown lists.

3.2 The parts of the food supply chain

The information asked for in all sheets corresponds to the following parts of the food supply chain (table 1):

	FUSIONS denominations		NACE codes
1	Primary production	Primary production (Agriculture and fishery)	NACE 01-03
2	Processing	Food manufacturing	NACE 10-11
3	Wholesale and logistics	Distribution	NACE 46
4	Retail and Markets	Distribution	NACE 47
5	Redistribution	Distribution	NA[2]
6	Food service[1]	Consumption	NACE 55-56
7	Household	Consumption	NA[2]

Table 1: The parts of the food supply chain

1. The data collection for food service has one row for the total amount of food waste in the food service sector. If there is total data for the sector, please specify in Comments and details which subcategories are included (for example if all activities with the NACE-code 56 is included or if also hotels with NACE-code 55 is included). Food service is divided into the subcategories Hotel, Restaurants and Catering/Canteens in the case that data are available for these specific activities. Statistics regarding more activities (for example hospitals) may exist, but in this data collection we consider hospitals to fit into the category of canteens. Fill in available data where it seems most appropriate and note any concerns over the mismatch between existing data and divisions in the sheets in the file and FUSIONS will take this into account.
2. There are no NACE codes for food redistribution and households.

The division of the food supply chains can also be explained in a diagram (figure 1):

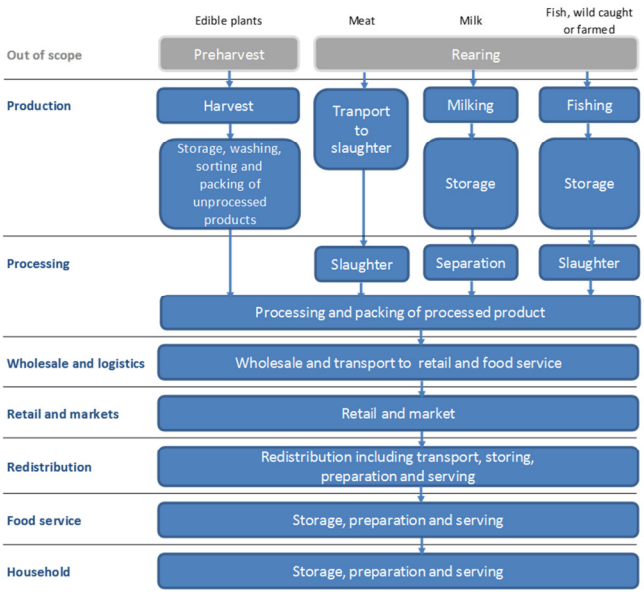


Figure 1: Supply step boundaries.
When the raw material is intact, it is still in the production stage. When it is cut, minced, mixed with other ingredients it is in the production stage. The flow of food in this diagram is simplified as in reality households get their food directly from retail and markets and not from food service. Furthermore, food service is served by wholesales and not by redistribution. Yet, this picture gives an overview of the different steps in the food supply chain.

3.3 The food waste categories

The food waste is divided into edible food products and substances and inedible parts. They make up the total food waste for the respective part of the food supply chain (figure 2).

Figure 2: The division of the total food waste into edible and inedible food waste

In sheet 2 and 3 we ask specifically for data on **liquid food waste** that have been measured separately. Liquid food waste is often going down the sewer (at least in households) and can for example consist of dairy products, beverages, oil and sauces. There is an increased interest of measuring this stream of food waste as it is not found together with the solid waste and thus normally does not get considered in the statistics. If there is no available study regarding this stream you leave these rows empty. Liquid food waste may already be partly or fully accounted for as wet substance in the categories of total food waste and/or in the edible food waste. If so, you can make this visible as you choose the share of liquid waste in one of the columns in all of the sheets.

4. The first sheet – Generated amounts of food waste (tons/year)

4.1 Are data available? (Dropdown list)

- Yes
- No
- Not now but for later reports

Fill in whether there is available data or not for all of the parts of the food supply chain and the different food waste categories. Choose the alternative "Not now but for later reports" if work to produce data is planned or in progress.

4.2 Generated amounts

Fill in the generated amounts in tons where there is available data. If there are only ranges available, these can be used and filled into the sheet. Only one amount (or range) for each part of the supply chain is to be filled into the sheet even if there are more data available. This means that if there is more than one study available for some parts of the supply chain the national representative could either choose the most reliable source or make a qualified estimation based on the available sources. Information of additional sources (that do not fit into the column sources) and methods of estimations should be added in the column Comments and details.

4.3 Specify the used definition and content of the food waste category

Specify how the food waste has been defined in the source/study. This classification could deviate from the FUSIONS definition and this is important to take into account when FUSIONS is analysing the data.

4.4 Share of liquid food waste (Dropdown list)

Liquid food waste is often going down the sewer (at least in households) and can for example consist of dairy products, beverages, oil and sauces. However, in some studies the dry-substance and water content is calculated for other waste fractions/food types as well. If the share of liquid waste is not known choose the alternative "Unknown". If the

share is calculated, specify the percentage, and if any other information regarding the liquid waste is available, please add it in the column Comments and details.

4.5 Estimated degree of uncertainty (Dropdown list)

- 0-10 % Accurate data
- 11-25 % Average
- <26 % High uncertainty

Estimate how much the data could deviate from the given amount. If there is a 100 % certainty that the data are correct then there is a 0 % degree of uncertainty. On the other hand, if the data are very unsecure the uncertainty could be 26 % or above. This information will give us a hint of the accuracy of the data. If there is no available information about the uncertainty, you can make a qualified guess. The chosen ranges of uncertainty are broad as FUSIONS assess that this is enough for the analysis that will be carried out after the collection of data. If you have more information on biases and uncertainties this can be added in the column Comments and details.

4.6 Methods for quantifying food wastage

Please provide information on how the data were obtained. The information of methods is of interest both to enable comparison of data between countries and also to follow trends in used methods. This data collection is using the same categories and terms as the other processes within FUSIONS to enable common work with the data-set.
The section is divided into method for data measuring, measure for data collection and method of up-scaling.

4.6.1 Method for data measuring (Dropdown list)

The methods for measuring food waste and wastage:

- Measurement (weighing or volume)
- Scanning (electronic recording)
- Composition waste analysis
- Diary
- Combination of methods

The figure below illustrates methods used to quantify food wastage before discarding or after discarding of the wastage.

Figure 3: Illustration of quantifying food wastage

4.6.2 Method for data collection (Dropdown list)

Data collection describes methods for collecting already existing data.

- Statistics (at national level or at other level e.g. country, municipality, company etc.)
- Interviews and surveys
- Mass and energy balances
- Questionnaires
- Combination of methods

4.6.3 Method of up-scaling

FUSIONS would like to know how the data have been extrapolated to national level. Please explain which type of waste factor and scaling factor that has been used. The information does not need to be quantified with numerical data. The waste factor is for example information about the waste amount per employee/year, per household/year or per served portion/year. The scaling factor may be turnover, number of employees, inhabitants, served portions etc. Add if any other factors were taken into account in the calculation, for example seasonality, and let us know whether the calculation was done in the original study or by the national representative, at the moment of the FUSIONS request for the data.

4.7 Source (Dropdown list)

Fill in a reference number in the dropdown list and put the details in the sheet called "references". We would like you to fill in as much information as possible about the source from where the data are retrieved (author, title, publisher, year, language and link to the source if found on the internet).

4.8 Year that data represent

Please state which year the data represents. FUSIONS prefer the most recent data available, yet if older data have higher quality it could be more relevant. Data from EUROSTAT that will be used in the analysis of the collected data represent 2010 and 2012.

4.9 Coverage of the data

Describe how and to what extent (qualitatively) specified data do not provide a complete coverage in respect to waste amounts, type of waste, part of the food supply chain etc. Also specify in the corresponding row of the provided data if it represents more than one of the parts of the supply chain, and if so which ones.

2. 4.10 Comments and details

If there is additional information that explains the data it can be noted in this cell and also in the last sheet of the file, called “Additional data”.

5. The second sheet – Treatment of generated food waste (%)

5.1 Are data available? (Dropdown list)

- Yes
- No
- Not now but for later reports

Please fill in whether there is available data or not for all of the parts of the food supply chain. Choose the alternative "Not now but for later reports" if work to produce data is planned or in progress.

5.2 Treated amounts

The amounts are prepopulated from previous sheets (apart from the liquid waste), which means it will automatically be filled with the same amounts as in table 1. See 4.2 for more details.

5.3 Specify the used definition and content of the food waste category

Specify how the food waste has been defined in the source/study. This classification could deviate from the FUSIONS definition and this is important to take into account when FUSIONS is analysing the data. If there are different definitions regarding every method of treatment, please specify this in the column for Comments and details.

5.4 Share of liquid waste (Dropdown list)

Liquid food waste is often going down the sewer (at least in households) and can for example consist of dairy products, beverages, oil and sauces. However, in some studies the dry-substance and water content is used for other waste fractions/food types as well. If the share of liquid waste in the food waste is calculated and known, specify the percentage, and if any other details regarding the liquid waste are known please add information into the column Comments and details. If it is not known choose the alternative "Unknown".

5.5 Methods of treatments

Choose the share of the different methods in the dropdown lists (1-100 %). If not used at all in the country choose "0%" and if percentage is not known leave it blank. There are eight columns representing different ways of treatment/disposal of the waste:

- Charity redistribution
- Animal feed
- Composting (central composting at official sites)
- Home composting
- Anaerobic digestion
- Waste water treatment plant
  (intended as well as unintentional waste down the drain, if data are known)
- Incineration with energy recovery
  (specify in Comments and details if incineration without energy recovery is practiced)
- Landfilling
- Other/Unknown
  (if this column is used, please specify details in the Comments and details)

5.6 Autosum of the treatment

The number in this section should, if the data collection is complete, add up to 100 % when data for a part of the supply chain is compiled.

5.7 Estimated degree of uncertainty (Dropdown list)

- 0-10 % Accurate data
- 11-25 % Average
- >26 % High uncertainty

Estimate how much the data could deviate from the given amount. If there is a 100 % certainty that the data are correct then there is a 0 % degree of uncertainty. On the other hand, if the data are very unsecure the uncertainty could be 26 % or above. This information will give us a hint of the accuracy of the data. If there is no available information about the uncertainty, you can make a qualified guess. The chosen ranges of uncertainty are broad as FUSIONS assess that this is enough for the analysis that will be carried out after the collection of data. If you have more information on biases and uncertainties this can be added in the column Comments and details.
The uncertainty may vary between the different forms of treatment/disposal options and this is the reason for asking both separately for this information regarding each method as well as asking for a total estimation for every part of the supply chain.

5.8 Methods for quantifying food waste

Please provide information on how the data were obtained. The methods for quantifying food waste treated or disposed of differ from the data collection for other data asked for in the National Food Waste Data Table. The data may be available separately on the different methods of treatment and not for the part of supply chain. With this in mind we have left the cells blank for the national representative to fill in and explain the methods used.

The section is divided into method for data measuring, measure for data collection and method of up-scaling.

5.8.1 Method for data measuring

Please, add details about how the primary data were measured.

5.8.2 Method for data collection

Data collection describes methods for collecting already existing data. Please, add details about how the primary data were collected.

5.8.3 Method for up-scaling

FUSIONS would like to know how the data have been extrapolated to national level. Please explain which type of waste factor and scaling factor that has been used. The information does not need to be quantified with numerical data. Let us know whether the calculation was done in the original study or by the national representative, at the moment of the FUSIONS request for the data.

5.9 Source (Dropdown list)

Fill in a reference number in the dropdown list and put the details in the sheet called "references". We would like you to fill in as much information as possible about the source from where the data are retrieved (author, title, publisher, year, language and link to the source if found on the internet).

In this sheet for treatment the data may come from different sources for every used method of disposal/treatment. If this is the case, please give information about this in the column for Comments and details.

5.10 Year that data represent

Please state which year the data represents. FUSIONS prefer the most recent data available, yet if older data have higher quality it could be more relevant. Data from EUROSTAT that will be used in the analysis of the collected data represent 2010 and 2012.

5.11 Coverage of the data

Describe how and to what extent (qualitatively) specified data do not provide a complete coverage in respect to waste amounts, type of waste, part of the food supply chain etc. Also specify if data represent more than one of the parts of the supply chain.

5.12 Comments and details

If there is addition information that explains the data it can be noted in this cell and also in the last sheet of the file, called “Additional data”.

6. The third sheet – Type of food waste products (%)

6.1 Is data available? (Dropdown list)

- Yes
- No
- Not now but for later reports

Please fill in whether there are available data or not for all of the parts of the food supply chain. Choose the alternative "Not now but for later reports" if work to produce data is planned or in progress.

6.2 The amount (tons) that shares of the food types refer to

The amounts are prepopulated from previous sheets (apart from the liquid waste), which means it will automatically be filled with the same amounts as in table 1. See 4.2 for more details.

6.3 Specify the used definition and content of the food waste category

Specify how the food waste has been defined in the source/study. This classification could deviate from the FUSIONS definition and this is important to take into account when FUSIONS is analysing the data.

6.4 Share of liquid waste (Dropdown list)

Liquid food waste is often going down the sewer (at least in households) and can for example consist of dairy products, beverages, oil and sauces. However, in some studies the dry-substance and water content is used for other waste fractions/food types as well. If the share of liquid waste in the food waste is calculated and known, specify the percentage, and if any other details regarding the liquid waste are known please add information into the column Comments and details. If it is not known choose the alternative "Unknown".

6.5 Share of food products

In this section we ask you to provide us with available data on share of food products. We know that the used divisions of food types in the MS differ but it would make comparisons easier if it was agreed on one classification system. One list that seems to be internationally accepted is the one used by FAO in their Code of Conduct for food

classification, with 16 main types of food products as a basis for classification of food waste:

01. Dairy products
02. Fats and oils, oil based products
03. Ice cream, sorbets etc.
04. Fruits and vegetables, including nuts and seeds
05. Confectionery
06. Cereals and cereal products
07. Bakery wares
08. Meat and meat products, including game
09. Fish and fish products, including molluscs and crustaceans
10. Eggs and egg products
11. Sweeteners, including honey
12. Salt, spices, soups etc.
13. Food stuff
14. Beverages, excluding dairy products
15. Ready to eat food
16. Composite food not possible to include in other groups

If available data has another classification/aggregation and it is difficult to convert it into the 16 types in the file, please provide the project group with existing data in another form and FUSIONS will use that as a basis for further analysis.

The data should be stated in percentage (%) in the dropdown lists. If data are not known leave the cell blank and if the food type is not included in the total amount of waste for the part of supply chain choose 0%.

6.6 Autosum of the food products

The number in this section should, if the data collection is complete, add up to 100 % when data for a part of the supply chain is compiled.

6.7 Estimated degree of uncertainty (Dropdown list)

- 0-10 % Accurate data
- 11-25 % Average
- <26 % High uncertainty

Estimate how much the data could deviate from the given amount. If there is a 100 % certainty that the data are correct then there is a 0 % degree of uncertainty. On the other hand, if the data are very unsecure the uncertainty could be 26 % or above. This information will give us a hint of the accuracy of the data. If there is no available information about the uncertainty, you can make a qualified guess. The chosen ranges of uncertainty are broad as FUSIONS assess that this is enough for the analysis that will be carried out after the collection of data. If you have more information on biases and uncertainties this can be added in the column Comments and details.
The uncertainty may differ between data regarding the different food types, yet we only ask for a collective estimation. If there is more details and information to share about specific considerations, please add this in column Comments and details.

6.8 Methods for quantifying food wastage

Please provide information on how the data were obtained. The information of methods is of interest both to enable comparison of data between countries and also to follow trends in used methods. This data collection is using the same categories and terms as the other processes within FUSIONS to enable common work with the data-set.
The section is divided into method for data measuring, measure for data collection and method of up-scaling.

6.8.1 Method for data measuring (Dropdown list)

The methods for measuring food waste and wastage:

- Measurement (weighing or volume)
- Scanning (electronic recording)
- Composition waste analysis
- Diary
- Combination of methods

The figure below illustrates methods used to quantify food wastage before discarding or after discarding of the wastage.

Figure 4: Illustration of quantifying food wastage

6.8.2 Method for data collection (Dropdown list)

Data collection describes methods for collecting already existing data.

- Statistics (at national level or at other level e.g. country, municipality, company etc.)
- Interviews and surveys
- Mass and energy balances
- Questionnaires
- Combination of methods

6.9 Source (Dropdown list)

Fill in a reference number in the dropdown list and put the details in the sheet called "references". We would like you to fill in as much information as possible about the source from where the data are retrieved (author, title, publisher, year, language and link to the source if found on the internet).

6.10 Year that data represent

Please state which year the data represents. FUSIONS prefer the most recent data available, yet if older data have higher quality it could be more relevant. Data from EUROSTAT that will be used in the analysis of the collected data represent 2010 and 2012.

6.11 Coverage of the data

Describe how and to what extent (qualitatively) specified data do not provide a complete coverage in respect to waste amounts, type of waste, part of the food supply chain etc. Also specify if data represent more than one of the parts of the supply chain.

6.12 Comments and details

If there is addition information that explains the data it can be noted in this cell and also in the last sheet of the file, called "Additional data".

Thank you for your contribution!

Annex E: Countries providing data

The matrix below describe to what extent data was taken into account when estimating the total food waste amounts.

Table 14. Summarizing evaluation of data provided by member states.

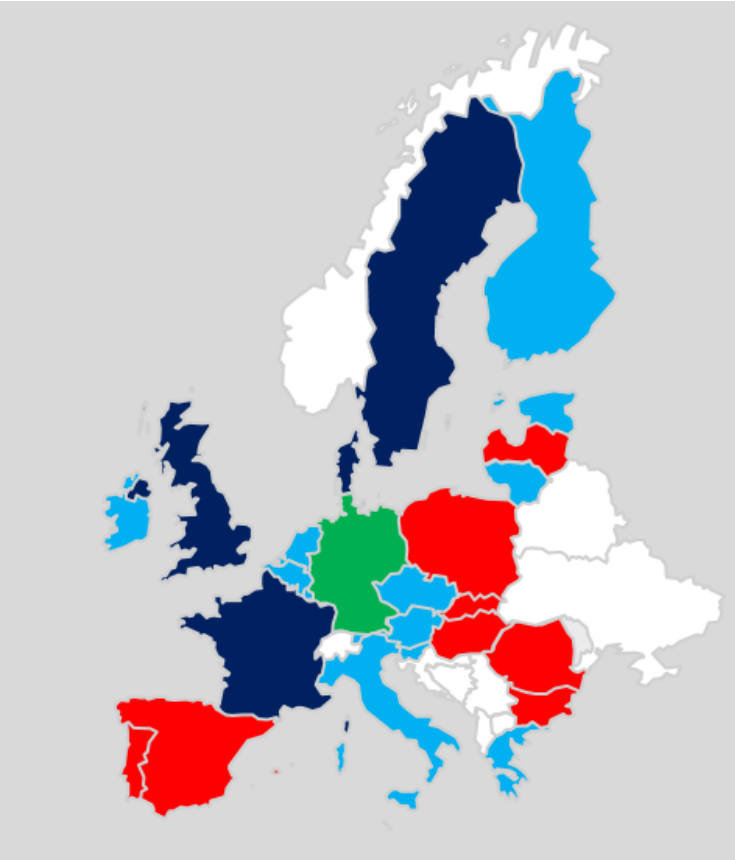
Country	1. Production (NACE 1-3)	2. Processing (NACE 10-11)	3. Wholesale and logistics (NACE 46)	4. Retail and markets (NACE 47)	5. Redistribution (food donation etc.)	6. Food service (NACE 56)	7. Household
Austria	No data available	Food waste data of low quality	No data available	Data of sufficient quality	Data has been submitted but no estimation of food waste amounts has been made.	Data of sufficient quality	Data of sufficient quality
Belgium	Food waste data of low quality	Food waste data of low quality	Food waste data of low quality	Food waste data of low quality	No data available	Food waste data of low quality	Food waste data of low quality
Bulgaria	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Croatia	Low food waste amounts	Low food waste amounts	Low food waste amounts. Several or major waste flows not being covered.	Low food waste amounts. Several or major waste flows not being covered.	No data available	Low food waste amounts. Several or major waste flows not being covered.	Low food waste amounts. Several or major waste flows not being covered.
Cyprus	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Czech republic	Low food waste amounts without any explanation given	Low food waste amounts	Food waste data of low quality	Food waste data of low quality	No data available	Lowfood waste amounts. No explanation on what was included.	Several or major waste flows not being covered.
Denmark	Data of sufficient quality	Data of insufficient quality as only edible food waste was reported.	Data of sufficient quality	Data of sufficient quality	No data available	Data of sufficient quality	Data of sufficient quality
Estonia	No data available	Low food waste amounts	Data of sufficient quality	Data of sufficient quality	No data available	Low food waste amounts	Data of sufficient quality
Finland	Data of sufficient quality	Data of insufficient quality as only edible food waste was reported.	No data available	High food waste amounts. No explanation on what was included.	No data available	Data of sufficient quality	Data of sufficient quality
France	Data of sufficient quality	Data of sufficient quality	High food waste amounts. No explanation on what was included.	High food waste amounts. No explanation on what was included.	No data available	Data of sufficient quality	No information on what was included was retrieved.
Germany	Data of sufficient quality	Data of sufficient quality	Data of sufficient quality	Data of sufficient quality	No data available	Data of sufficient quality	Data of sufficient quality
Greece	Low food waste amounts without any explanation given	High food waste amounts.	Data of sufficient quality	Data of sufficient quality	No data available	Low food waste amounts. No information on what was included was retrieved.	No information on what was included was retrieved.
Hungary	No data available	No data available	No data available	No data available	No data available	No data available	No data available

Ireland	No data available	No data available	High food waste amounts. No information on what was included was retrieved.	High food waste amounts. No explanation on what was included.	Data has been submitted but no estimation of food waste amounts has been made.	Data of sufficient quality	Data of sufficient quality
Italy	Data of sufficient quality	Data of insufficient quality as only edible food waste was reported.	Data of sufficient quality	Data of sufficient quality	No data available	Data of insufficient quality as only edible food waste was reported.	No information on what was included was retrieved.
Latvia	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Lithuania	Low food waste amounts	Data of sufficient quality	Data of insufficient quality.	Data of insufficient quality.	No data available	Data of insufficient quality.	No information on what was included was retrieved.
Luxembourg	No data available	Low food waste amounts without any explanation given	Data of sufficient quality	Data of sufficient quality	No data available	Low food waste amounts without any explanation given	Data of sufficient quality (excluding sewer and home composting)
Malta	No data available	Data of insufficient quality.	No data available	No data available	No data available	No data available	Data of sufficient quality (excluding sewer and home composting)
Netherlands	No data available	No data available	No data available	Data of sufficient quality	Data has been submitted but no estimation of food waste amounts has been made.	Several or major waste flows not being covered.	Data of sufficient quality (excluding home composting)
Poland	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Portugal	No information on what was included was retrieved.	No information on what was included was retrieved.	No data available	No data available	No data available	No data available	No data available
Romania	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Slovakia	Low food waste amounts. Several or major waste flows not being covered.	Several or major waste flows not being covered.	No data available	No data available	No data available	No data available	No data available
Slovenia	Low food waste amounts. Several or major waste flows not being covered.	No explanation of what was included in the amounts could be given.	Data of sufficient quality	Data of sufficient quality	No data available	Low food waste amounts. Several or major waste flows not being covered.	Park waste and non household MSW are included in the amounts
Spain	No data available	No data available	No data available	No data available	No data available	No data available	No data available
Sweden	Data of sufficient quality	Byproducts are included in the amounts.	No data available	Data of sufficient quality	No data available	Data of sufficient quality	Data of sufficient quality
United Kingdom	Data of insufficient quality.	Data of sufficient quality	Data of sufficient quality	Data of sufficient quality	No data available	Data of sufficient quality	Data of sufficient quality

To visualize total data quality for food waste statistics in EU-28 we have developed a map where each country has a colour based in a total quality score. Based in Table x in Appendix w a total score per country has been calculated. For each sector in the food chain, values have been given as

0: Data not available (red cell)
1: Data available, but with insufficient quality (yellow cell)
2: Data available and of sufficient quality (green cell).
A total score has been calculated by summing up all values for single sectors, and finally, categories shown up as colours in the map have been defined.

One country get the highest score (Germany; total score 12 of 14 possible), whereas four countries reach the second highest level (Sweden, Denmark, UK and France). Those countries have high values for most sectors and with few data gaps. Eight countries have the lowest score, which in fact means that no sector has data available with sufficient quality to present food waste statistics for the country.



Annex F: Country specific tables

In this Annex the data provided and used is shown as is the calculations to obtain the factor to be used for upscaling. The figures shown in the tables and the calculations are unrounded, so that the calculations are easier to follow. However, these results have been rounded to an appropriate number of significant figures when quoted in the main body of this report, reflecting the level of uncertainty associated with the results.

In the work the choice was made to weight the data using an unweighted average (mean) for which smaller countries have the same impact on the average as a large country rather than to weight the data according to the 'size' of the country or by trying to estimate which countries that might be good proxies for other countries (e.g. household food waste in Belgium may be similar to the Netherlands, although their production food waste may be very different). The reason for this decision being that the calculations are kept relatively simple (allowing others to follow) and that would be of greater benefit than getting into tricking weighting schemes. In future projects, as more data is generated in the future and the accuracy increases, more sophisticated schemes for scaling up data may be worth considering.

F.1 Production

Table 15. Underlying data and calculations for food waste estimations for the production sector.

Country	Food waste (tonnes)	Food amounts produced (tonnes)	Food waste (kg food waste /tonne of food produced)	Reference
Denmark[1]	169 000	22 796 969	7.4	Swedish Board of Agriculture, 2016
Finland[1]	63 000	7 901 090	8.0	Swedish Board of Agriculture, 2016
France	1 990 063	161 552 568	12.3	Redlingshöfer, 2015a
Germany	1 186 244	138 551 300	8.6	Priefer et al, 2013
Italy	1 246 603	71 832 125	17.4	Segrè and Falasconi, 2011
Sweden[1]	111 000	12 632 060	8.8	Swedish Board of Agriculture, 2016
Total	**4 765 910**	**415 266 111**	-	
Average (mean)	-	-	**10.4**	

[1] *The figures is calculated from the preliminary report (Swedish Board of Agriculture, 2016), please see the final report for the final data.*

Total food amounts produced for countries which have no food waste data available or have food waste data of insufficient quality = 416 197 485 tonnes
Multiply by above average and divided by 1000 (10.4×416 197 485)/1000) leads to
4 329 046 tonnes

Total for EU28= 4 329 046+4 765 910=9 094 956 tonnes.

F.2 Processing

Table 16. Underlying data and calculations for food waste estimations for the processing sector.

Country	Food waste (tonnes)	Food amounts produced (tonnes)	Food waste (kg / tonne of food produced)	Reference
France	626 000	125 847 319	5.0	Bio Intelligence Service, 2010
Germany	1 850 000	132 872 888	13.9	ISWA University of Stuttgart, 2012
Lithuania	105 870	4 798 212	22.1	Lithuanian waste statistics, 2015
United Kingdom[1]	3 900 000	84 120 902	46.4	WRAP, 2013a
Total	**6 481 870**	**347 639 320**	**-**	
Average (mean)	**-**	**-**	**21.8**	

[1] *WRAP is undertaking new research aimed at updating the estimate of food waste from processing in the UK, which will be published spring 2016. It is likely to be significantly lower than the one reported here for 2011*

Total food amounts produced for countries which have no food waste data available or have food waste data of insufficient quality = 476 485 561 tonnes
Multiply by above average and divided by 1000 (21.8×476 485 561)/1000) leads to 10 402 107 tonnes
Total for EU28 = 6 481 870+10 402 107=16 883 977 tonnes

F.3 Food service

Table 17. Underlying data and calculations for food waste estimations for the food service sector.

Country	Food waste (tonnes)	Turnover (€million) PPP adjusted	Amounts (ton/€million) PPP adjusted	Reference
Austria	280 000	17 590	15.9	Schneider et al, 2012
Denmark	115 700	5 536	20.9	Environmental protection agency Denmark, 2014
Finland	130 000	5 812	22.4	Katajajuuri et al, 2014; Silvennoinen et al, 2012; HSY, 2013[14]
France	1 080 000	93 429	11.6	Bio Intelligence Service, 2010
Germany	1 900 000	63 611	29.9	ISWA University of Stuttgart, 2012
Ireland	258 900	9 321	27.8	Environmental Protection Agency Ireland, 2015
Sweden	200 000	10 688	18.7	Swedish EPA, 2014; Stare et al, 2013
United Kingdom	920 000	91 352	10.1	WRAP, 2013b
Total	**4 884 600**	**297 338**	-	
Average (mean)	-	-	**19.6**	

Total turnover (PPP adjusted) for countries which have no food waste data available or have food waste data of insufficient quality = 287 206 €million
Multiply by above average (19.6×287 206) leads to 5 642 737 tonnes
Total for EU28= 5 642 737+4 884 600= 10 527 337 tonnes

[14] Katajajuuri et al, 2014; Silvennoinen et al, 2012 reports 80 000 tonnes of avoidable food waste and HSY, 2013 reports 50 000 tonnes of unavoidable food waste.

F.4 Wholesale and retail

Table 18. Underlying data and calculations for food waste estimations for the wholesale and retail sector.

	Retail			Wholesale			Retail and wholesale	Reference
Country	**Food waste (tonnes)**	**Population (people)**	**Food waste (kg / person / yr)**	**Food waste (tonnes)**	**Population (people)**	**Food waste (kg / person / yr)**	**Food waste (tonnes)**	
Austria	74 100	8 451 000	8.8	-	-	-	-	Lebersorger and Schneider, 2014
Denmark	167 100	5 602 600	29.8	5 200	5 602 600	0.9	-	Environmental protection agency Denmark, 2014
Estonia	-	-	-	-	-	-	6 270	Moora et al, 2015
Germany	490 000	80 523 700	6.1	60 000	80 523 700	0.7	-	ISWA University of Stuttgart, 2012
Greece	-	-	-	-	-	-	79 718	Greek waste statistics, 2011
Italy	270 776	59 685 200	4.5	118 317	59 685 200	2.0	-	Segrè and Falasconi, 2011
Luxembourg	2 099	537 000	3.9	595	537 000	1.1	-	Luxembourgh waste statistics, 2015
Netherlands	18 ,000	16 779 600	11.0				-	De Waart, 2011
Sweden	69 676	9 555 900	7.3	-	-	-	-	Swedish EPA, 2014
United Kingdom[1]	403 500	63 888 000	6.3	17 297	63 888 000	0.3	-	WRAP, 2013b
Total	**1 675 714**	**247 082 000**		**203 618**	**212 295 300**	-	**85 988**	
Average (mean)	-	-	**9.4**[15]	-	-	**1.0**[16]	-	

[1] *A more recent estimate of food waste arising at retail and wholesale in the UK has been published by WRAP, made up of a retail estimate for 2014 (210 000 tonnes) and a wholesale estimate for 2011 (17 000 tonnes). Details can be found at http://www.wrap.org.uk/content/uk-handy-waste-facts-and-figures-retail-sector*

Total population for retail for countries which have no food waste data available or have food waste data of insufficient quality = 246 260 400 people
Total population for wholesale for countries which have no food waste data available or have food waste data of insufficient quality = 281 047 800 people

[15] The average value is not only based on reported amounts from the countries shown in the table but also based on countries which do no want their food waste data to be published.

[16] The average value is not only based on reported amounts from the countries shown in the table but also based on countries which do no want their food waste data to be published.

Multiply by above average and divided by 1000 (9.4×246 260 400/1000) = 2 306 506 tonnes for the retail sector
Multiply by above average and divided by 1000 (1,0×281 047 800/1000) = 286 103 tonnes for the wholesale sector

Total for EU28 = 2 306 506+286 103+1 675 714+203 618+85 988= 4 557 929 tonnes

F.5 Households

F.5.1 Collected by local authorities / municipalities

Table 19. Underlying data and calculations for food waste estimations for the household sector, collected by local authorities / municipalities.

Country	Food waste (tonnes)	Population (people)	Food waste (kg / person / yr)	Reference
Austria	369 000	8 451 900	43.7	Schneider et al, 2012
Denmark	462 774	5 602 600	82.6	Environmental Protection Agency Denmark, 2014b
Estonia	70 000	1 324 800	52.8	Moora et al, 2015
Finland	345 000	5 426 700	63.6	Katajajuuri et al, 2014; Silvennoinen et al, 2013;HSY, 2012[17]
Germany	5 050 000	80 523 700	62.7	ISWA University of Stuttgart, 2012
Ireland	251 000	4 591 100	54.7	Environmental Protection Agency Ireland, 2015
Luxembourg	42 374	537 000	78.9	Food waste plug-in Luxembourg ,2012
Malta	54 604	421 400	129.6	Maltese waste statistics 2012
Netherlands	1 119 199	16 779 600	66.7	van Westerhoven & Steenhuisen, 2010
Sweden	683 529	9 555 900	71.5	Swedish EPA, 2014
United Kingdom	4 670 000	63 888 000	73.1	WRAP, 2013c
Total	**13,117,481**	**197,102,700**	-	
Average (mean)	-	-	**70.9**	

Total population for countries which have no food waste data available or have food waste data of insufficient quality = 308 627 700 people

[17] Katajajuuri et al, 2014; Silvennoinen et al, 2013 reports 120 000 tonnes of avoidable food waste and HSY, 2013 reports 230 000 tonnes of unavoidable food waste.

Multiple by above average (70.9 kg / person / year) and convert to tonnes leads to 21 880 846 tonnes.
Total for EU28 = 21 880 846 + 13 117 481 = 34 998 327 tonnes

F.5.2 Sewer

Table 20. Underlying data and calculations for food waste estimations for the household sector, food waste down the sewer.

Country	Food waste (tonnes)	Population (people)	Food waste (kg / person / yr)	Reference
Austria	75 267	8 451 900	8.9	Schneider et al, 2012
Germany	940 000	80 523 700	11.7	ISWA University of Stuttgart, 2012
Netherlands	104 034	16 779 600	6.2	van Westerhoven & Steenhuisen, 2010
Sweden	224 000	9 555 900	23.4	Sörme et al, 2014
United Kingdom	1 561 543	63 888 000	24.4	WRAP 2013c
Total	**2 904 844**	**179 199 100**	-	
Average (mean)	-	-	**14.9**	

Total population for countries which have no food waste data available or have food waste data of insufficient quality = 326 531 300 people

Multiple by above average (14.9 kg / person / year) and convert to tonnes leads to 4 875 884 tonnes.
Total for EU28 = 4 875 884 + 2 904 844 = 7 780 727 tonnes

F.5.3 Home composting

Table 21. Underlying data and calculations for food waste estimations for the household sector, food waste to home composting.

Country	Food waste (tonnes)	Population (people)	Food waste (kg / person / yr)	Reference
Austria	90 321	8 451 900	10.7	Schneider et al, 2012
Germany	73 000	80 523 700	9.1	ISWA University of Stuttgart, 2012
Sweden	48 700	9 555 900	5.1	Avfall Sverige, 2014
United Kingdom	510 000	63 888 000	8.0	WRAP 2013c
Total	**1 393 021**	**167 010 600**	-	
Average (mean)	-	-	**7.0**[18]	

Total population for countries which have no food waste data available or have food waste data of insufficient quality = 338 719 800 people

[18] The average value is not only based on reported amounts from the countries shown in the table but also based on countries which do no want their food waste data to be published.

Multiple by above average (7.0 kg / person / year) and convert to tonnes leads to 2 361 120 tonnes.

Total for EU28 = 2 361 120 + 1 393 021 = 3 754 141 tonnes

F.5.4 Overall total for households

The overall total for households is the sum of the above three destinations for food waste

Table 22. Underlying data and calculations for food waste estimations for the household sector, total.

Destination for food waste	Weight of food waste (tonnes)
Households	34 998 327
Sewer	7 780 727
Home composting	**3 754 141**
Total	**46 533 195**

Annex G : Studies not included

As seen in Annex E there are several countries providing data for different sectors that is not of sufficient quality for the task performed here. However these studies sometimes still might give good insight on food waste data and methodology.

G.1 Production

Table 23. Studies not used for the production sector.

Country	Reference	Reason for not including the data in the estimations
Belgium	Food waste plug-in Belgium, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Croatia	Food waste plug-in Croatia, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Czech republic	Food waste plug-in Czech republic, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Greece	Greek waste statistics, 2011	Very low food waste amounts.
Lithuania	Food waste plug-in Lithuania, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Norway	Swedish Board of Agriculture, 2016	Data from Norway has been excluded as Norway is not part of EU-28.
Portugal	Baptista et al, 2012	High food waste amounts, without any information on what is included and not.
Slovakia	Food waste plug-in Slovakia, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality. In addition major flows are not included.
Slovenia	Slovenian waste statistics, 2012	Low food waste amounts where major waste flows are not included.
United Kingdom	(WRAP, 2015b)	High food waste amounts.

G.2 Processing

Table 24. Studies not used for the processing sector.

Country	Reference	Reason for not including the data in the estimations
Austria	Food waste plug-in Austria, 2012	Data from "food waste plug-in" which is of insufficient quality.
Belgium	Food waste plug-in Belgium, 2012	Data from "food waste plug-in" which is of insufficient quality.
Croatia	Food waste plug-in Croatia, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Czech republic	Food waste plug-in Czech republic, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Denmark	CONCITO, 2011	Only edible food waste included in the amounts which are low.
Estonia	Moora et al, 2015	Low food waste amounts.
Finland	Katajajuuri et al, 2014	Only edible food waste included in the amounts.
Greece	Ministry of Environment Energy and Climate Change of Greece, 2012	High food waste amounts without any reason given.
Italy	Segrè and Falasconi, 2011	Only edible food waste included in the amounts.
Luxembourg	Food waste plug-in Luxembourg, 2012	Data from "food waste plug-in" which is of insufficient quality. In addition no information on food production volumes.
Malta	Food waste plug-in Malta, 2012	Data from "food waste plug-in" which is of insufficient quality. In addition no information on food production volumes.
Norway	Hanssen et al, 2011	Data from Norway has been excluded as Norway is not part of EU-28.
Portugal	Baptista et al, 2012	Very low food waste amounts where several waste flows are not covered.
Slovakia	Food waste plug-in Slovakia, 2012	Data from "food waste plug-in" which is of insufficient quality where several waste flows are not covered.
Slovenia	Slovenian waste statistics, 2012	No explanation of what was included in the amounts could be given.
Sweden	Swedish EPA, 2014	High food waste amounts. The non edible part includes by-products such as feed milk and residues from offals.

G.3 Wholesale and retail

Table 25. Studies not used for the wholesale and retail sector.

Country	Reference	Reason for not including the data in the estimations
Belgium	Food waste plug-in Belgium, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Croatia	Food waste plug-in Croatia, 2012	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality.
Czech republic	Food waste plug-in Czech republic ,2012,	Very low food waste amounts where data is based on "food waste plug-in" which is considered to be of insufficient quality. E.g the food waste in the mixed waste/residual waste is not included..
Finland	Stenmarck and Hanssen et.al,2012	High food waste amounts which only include edible food waste.
France	Bio Intelligence Service, 2010	No explanation on what has been included in the reported amounts.
Ireland	Environmental Protection Agency Ireland, 2015	High food waste amounts.
Lithuania	Food waste plug-in Lithuania, 2012	A general fraction of the food waste in the MSW which represents the largest amounts from the sector has been applied for all sectors which is insufficient.
Norway	Hanssen et al, 2011	Data from Norway has been excluded as Norway is not part of EU-28.

G.4 Food service

Table 26. Studies not used for the food service sector.

Country	Reference	Reason for not including the data in the estimations
Belgium	Food waste plug-in Belgium, 2012	Food waste amounts is based on "food waste plug-in" which is considered to be of insufficient quality.
Croatia	Food waste plug-in Croatia, 2012	The food waste amounts are extremely low, No details on what is included in the food waste amounts were given. In addition PPP figures are missing.
Czech republic	Food waste plug-in Czech republic, 2012	Data is based on "food waste plug-in" which is considered to be of insufficient quality. In addition the food waste amounts are very low.
Estonia	Moora et al, 2015	Uncertainties on what is included in the amounts.
Greece	Greek waste statistics, 2011	Very low food waste amounts where it is not clear what flows are included in the amounts.
Italy	Garrone and Melacini, 2012 Garrone and Melacini, 2014	Only the edible food waste is included in the amounts which are also very low.
Lithuania	Food waste plug-in Lithuania, 2012	Very low food waste amounts. Insufficient data on what is included
Luxembourg	Food waste plug-in Luxembourg, 2012	Data is based on "food waste plug-in" which is considered to be of insufficient quality. In addition the food waste amounts are very low.
Netherlands	Jansen, 2007	Insufficient data as it only includes food waste from traditional restaurants. The food waste amounts are however very large as only traditional restaurants are included.
Slovenia	Slovenian waste statistics, 2012	Very low food waste amounts where food waste from schools, elderly homes, hospitals etc. are missing.

G.5 Households

Table 27. Studies not used for the household sector.

Country	Reference	Reason for not including the data in the estimations
Belgium	Food waste plug-in Belgium, 2012	Data for Brussels only - extrapolation to Belgium not recommended by those who produced figures.
Croatia	Food waste plug-in Croatia, 2012	The data did not conform to the FUSIONS definition – it didn't cover the relevant waste streams and did not differentiate food waste from other material.
Czech republic	Food waste plug-in Czech republic, 2012	Data not appropriate for analysis - insufficient information
France	Bio Intelligence Service, 2010	Data appears old and have not tracked down the methodology why it was decided to exclude the data.
Greece	EPSILON SA, Ecosfairiki-Mandilas Christoforos, DELPHI ENGINEERING, 2014	Methodology not clear - hard to assess - recommend not including
Italy	Waste Watcher, 2013	The data did not conform to the FUSIONS definition – it didn't cover the relevant waste streams and did not differentiate food waste from other material.
Lithuania	Food waste plug-in Lithuania, 2012	The data did not conform to the FUSIONS definition – it didn't cover the relevant waste streams and did not differentiate food waste from other material.
Norway	Hanssen O.J.,Skogesal O, 2013	Data from Norway has been excluded as Norway is not part of EU-28.
Slovenia	Slovenian waste statistics, 2012	Park waste and non houshold MSW are included in the amounts.

Estimates of European food waste levels

Name: IVL Swedish Environmental Research Institute
Address: Box 210 60, 100 31 Stockholm, Sweden
Phone: +46 10 788 65 66
E-mail: asa.stenmarck@ivl.se
Website: www.ivl.se