Food service measurement methods

Recap: Food service

- Meals or food prepared for consumption out of the home
- Can contain many different subsectors – prioritise those which are the largest / likely to serve the most food

- **‘Food waste’** contains **food** and **inedible parts**

- **Level 2 reporting:** total amount (fresh mass) food waste
- **Level 3 reporting:**
  - Share of food waste which was edible parts
  - Destination of waste

Defining food waste in food service

In some settings (e.g. canteens/buffets), '**serving**' waste could be counted separately

- **Three main stages where food waste can arise**

Inventory

Stocked food (pre-prepared or unprepared) disposed without being served

Photo by Bilge Şeyma Kütükoğlu from Pexels

Preparation

Food removed during preparation

Photo by Toa Heftiba on Unsplash

Consumer

Food leftover by consumers in plates/bowls/cups/disposable containers

Overview of section

- **Level of ambition for measuring food-service food waste**
- **Measurement methods: primary data**
- **Three ‘frameworks’ for quantification:**
  1) Building an estimate from sub-sector studies
  2) Businesses measure and report food waste via a voluntary agreement
  3) Businesses mandated to measure and report food waste

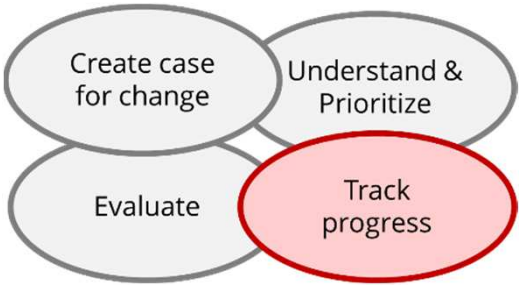
Ambition level for measuring food-service food waste

- Measuring FS food waste to an accuracy required for tracking is problematic
  - Multiple sub-sectors
  - Expensive to acquire primary data
  - Scaling to obtain a national estimate can present problems

Measurement methods

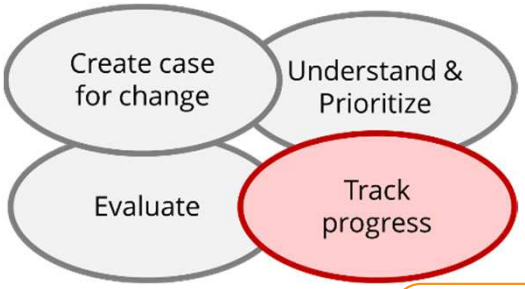
Sector	Methods of measurement					
Manufacturing (if included)				Mass balance		
Retail	Direct measurement (for food-only waste streams)	Waste composition analysis (for waste streams in which food is mixed with non-food)	Volumetric assessment		Counting/ scanning	
Food service						Diaries (for material going down sewer, home composted or fed to animals)
Household						

How to measure / obtain primary data?



- Weighing food-only collections
- Assessment of volume of waste bins
- Scanning / counting
- Smart bins
- Waste compositional analysis for mixed waste streams

How to measure / obtain primary data?



- Weighing food-only collections
- Assessment of volume of waste bins
- Scanning / counting
- Smart bins
- Waste compositional analysis for mixed waste streams

Requires food waste to be in separate bin

Can analyse food waste in mixed bin

Weighing and assessing volume

- **Weighing**
  - Weighing receptacles filled with waste
  - Requires food waste to be separated from non-food
  - May be received by waste contractors if businesses charged by weight disposed
- **Assessing volume**
  - Estimate amount via number of bins filled and how full they are
  - Requires food waste to be separated from non-food
  - Less accurate than weighing…

    … but may be lower cost

Scanning / counting

- Counting or scanning items as they become waste
- **Scanning:** relevant for packaged items (e.g. using barcode)
- **Counting:** appropriate for discrete items (e.g. 10 mangos)
  - Need to know average weight of item
- Not applicable to mixed/semi-prepared waste, e.g. vegetable skins or leftovers

- May have minor role in Food Service, e.g. for inventory/stock room

Smart technologies – digital bin
Weighing / waste compositional analysis

Scales for weighing

Interface for inputting information about food

(Camera + Artificial intelligence to automatically identify food)

Database to record food waste, provide info

Summary of measurement methods

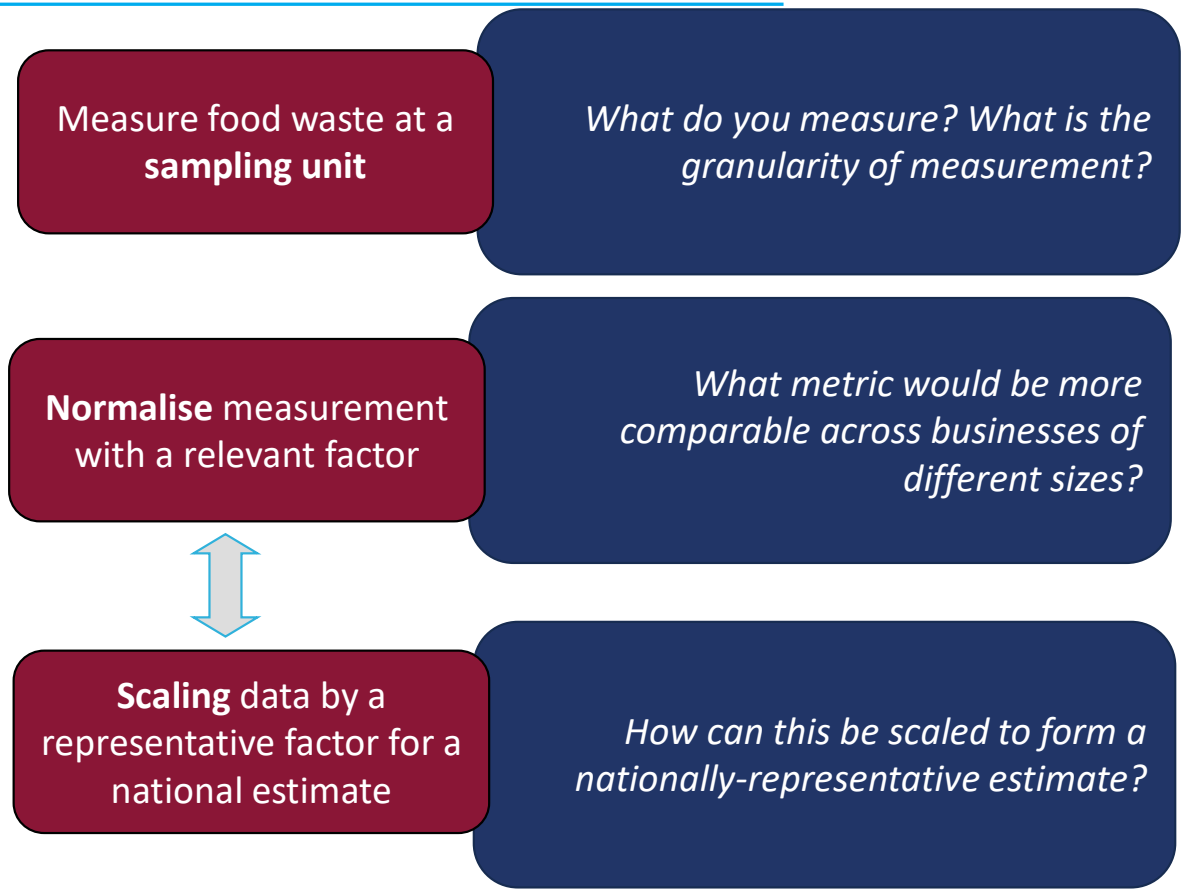
	Accuracy of measurement	Coverage of all FW in sector	Measurement causes behaviour change?	Detailed information possible?	Cost?
Weighing	High	Only covers segregated streams (food waste only)	Low	No	Low
Volumetric analysis	Lower: estimating volume	Only covers segregated streams (food waste only)	Low	No	Low
Direct weighing (digital bin)	High	High	High	Yes	High
Waste compositional analysis	High	High	Low	Yes	High
Scanning / counting	High	Only scannable / countable items	Low	Yes	High

Do restaurants and other food service in your country normally separate their food waste?

How could they be encouraged to do so?

Food service scaling

Three key steps



Sampling units in food service

Measure food waste at a **sampling unit**

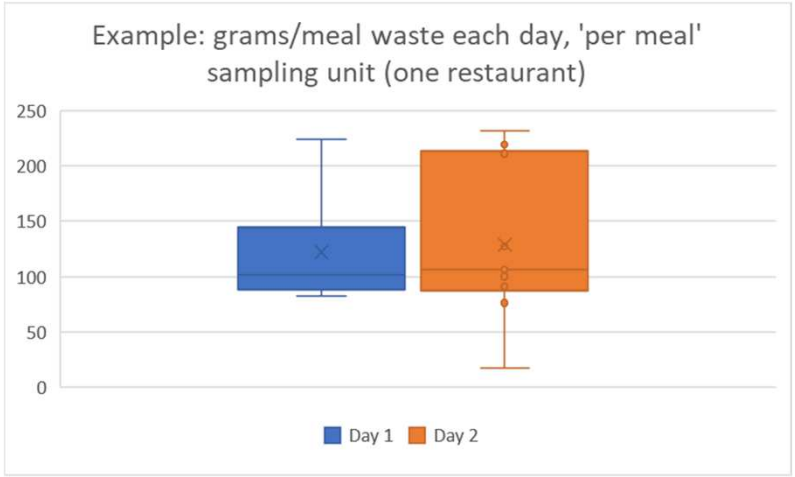
What is the granularity of measurement?

What might be a suitable sampling unit?

- **An individual meal:** measure waste from each individual meal
- **A kitchen/premise:** measure waste each day/week within a kitchen, or premise with multiple kitchens
- **A business (possibly with multiple sites):** e.g., where existing data provided to government for all sites owned by a business (e.g. chain businesses)

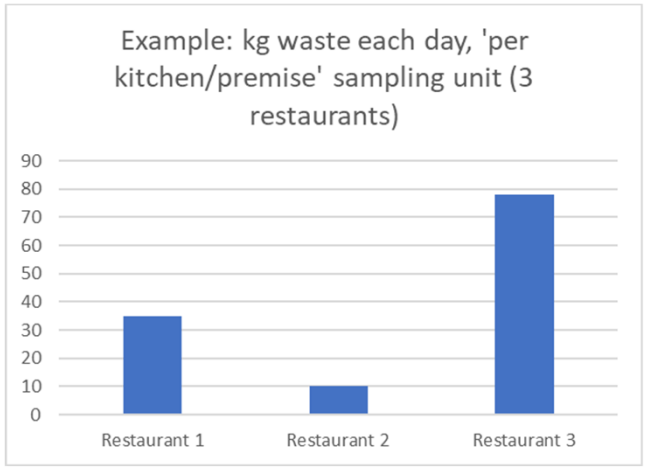
Sampling units

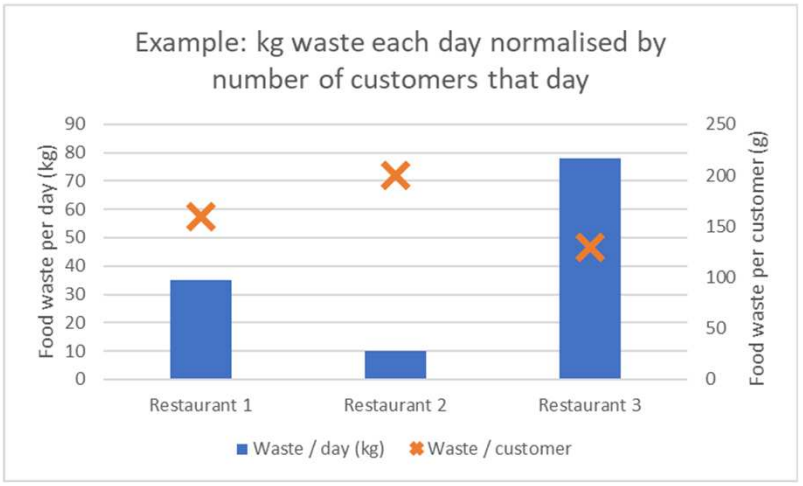
Sampling unit	Pros	Cons / points to consider
Individual meal	Quickly build up large dataset (good for statistics) High resolution Observe variation within customers at same site	Costly – many measurements Primarily captures plate waste – difficult to apportion serving/prep waste to individual meals Likely to miss drink waste unless captured separately



Sampling units

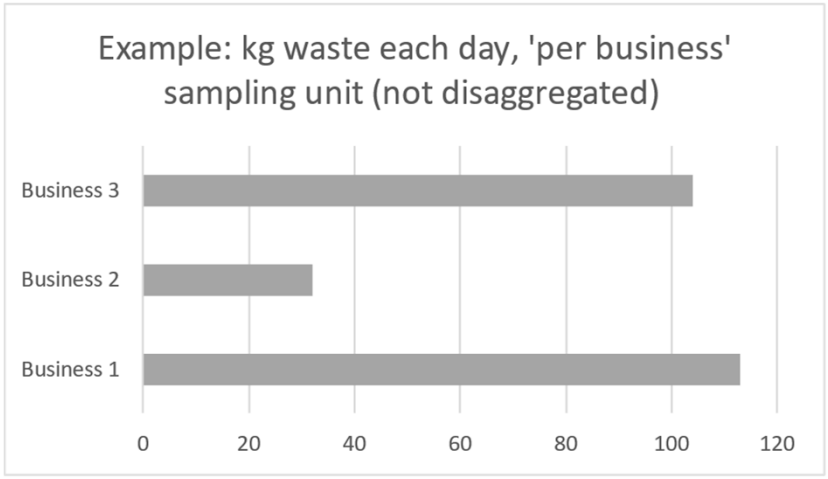
Kitchen/ premise	Natural unit for measurement and scaling Can capture waste for all stages of food service Can be normalised through POS data May capture drink waste even if disposed in different area to food waste	Does not capture variation between customers of same site If multiple kitchens at same site, need to understand flow of food between them

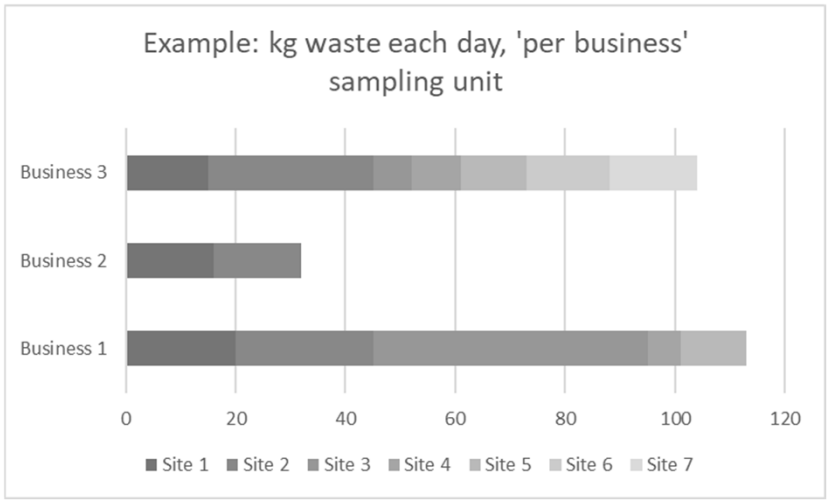




Sampling units

Business	Allows data for a large entity to be reported quickly May capture drink waste even if disposed in different area to food waste	Requires additional data for normalisation, comparison and scaling May lose nuance on where waste arises





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Normalising and scaling in food service

Normalise measurement with a relevant factor

What metric would be more comparable across businesses of different sizes?

How would we compare food waste generated in the two scenes below?

Normalising and scaling in food service

Normalise measurement with a relevant factor

What metric would be more comparable across businesses of different sizes?

- **Normalising an important step ahead of scaling**
- **Normalising data = dividing by relevant quantity**
- **Normalising data is also useful for analysis and communicating data**

Options for normalising food-waste data?

- Weight of food waste:
  - As % of food served / entering kitchen
  - per meal / portion / guest (cover)
  - per kitchen / premise
  - per unit of turnover or value of sales (e.g., kg FW / US$ turnover)
  - per employee

More details in Appendix C of *Food Loss and Waste Reporting and Accounting Standard*
https://flwprotocol.org/wp-content/uploads/2017/05/FLW_Standard_final_2016.pdf

Normalising and scaling in food service

Scaling data by a representative factor for a national estimate

How can this be scaled to form a nationally-representative estimate?

- **Scaling necessary to obtain a national estimate**
  - From sample => population
- **Close relationship between normalisation data and scaling data**
  - Need to be able to access that for both the entity in the sample AND for the nation/region being studied

Example: scaling from sample to nation

- Sub-sector = **restaurants**.
- 50 restaurants sampled: 3 days' worth of **food waste** measured via waste comp = 300 kg
- Have data for sample and nation on total **food served** in restaurants:
  - 2,000 kg in sample over 3 days
  - 1 million tonnes in country per year
- Can normalise sample data… $\frac{300\ \text{kg}}{2{,}000\ \text{kg}} = 15\%$
- … and apply to nation $15\% \times 1\ \text{mil. tonnes} = 150{,}000\ \text{tonnes}$

More details in Appendix C of *Food Loss and Waste Reporting and Accounting Standard*
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Example 2: scaling from sample to nation

- Sub-sector = **sports events (football matches)**.
- 10 sports events sampled: 10 days' worth of **food waste** measured by direct weighing = 10,000 kg (10 tonnes)
- Have data for number of attendees to those football matches: 200,000
- Can normalise sample data… $\frac{10 \text{ tonnes}}{200{,}000 \text{ people}} = 50g \; per \; person$
- Have data on annual attendees of football matches: 6 million people (30 weeks of 200k attendees)
- … use this to scale $50\text{g} \times 6 \text{ mil.} \text{attendees} = 300 \text{ tonnes}$

More details in Appendix C of *Food Loss and Waste Reporting and Accounting Standard*
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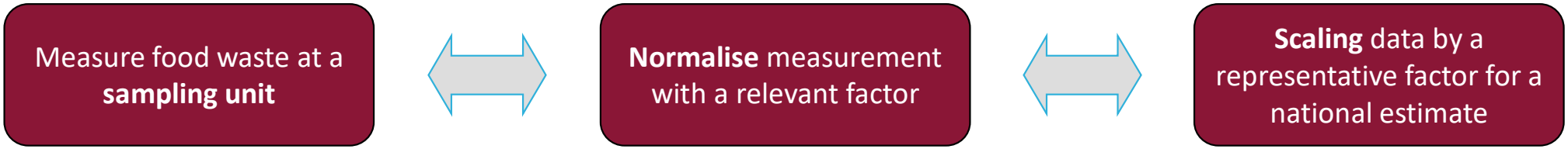
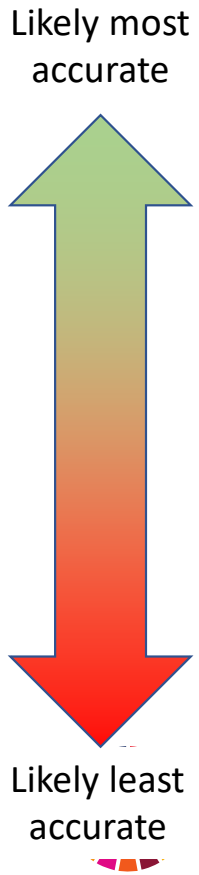
Normalising and scaling in food service



- **Sampling unit, normalising and scaling are connected**
- **Normalising** by something you can't **scale by** not that helpful
- Some **sampling units** are more suited to **normalisation** than others, or some data more available than others

Methods for normalisation and scaling

Normalisation factor	Accuracy of normalisation factor	Obtaining data from sampling unit	Obtaining data for whole country
Amount of food served (mass)	High: Likely to be lower levels of variation when normalising using the amounts of food	Might be recorded by kitchen / business	May be collected as national statistics or by trade body
Meals/covers served	High: likely to be lower level of variation when normalising using meals	Likely to be recorded by POS system	May be collected as national statistics or by trade body
Number of kitchens/sites	Intermediate: kitchens and sites can vary in size, particularly if multiple kitchens in a single site	Easy if sampling unit is kitchen/site, care needed for multiple kitchens on one site	Could be available through national statistics (e.g. licensing/food safety databases), care needed where multiple kitchens
Value of sales / turnover	Intermediate: need to be aware of (a) cost of food varying within subsector (e.g., different types of restaurant) and (b) inflation can cause problems when making comparisons over time	Probably recorded by POS but may be commercially sensitive	Data likely to be available
Employees	Intermediate: similar to turnover	Likely to be recorded by POS, business or sites	Could be available as part of national statistics
Businesses	Poor: businesses vary in size enormously; so will their level of FW	Easy if sampling unit is business	Could be available as part of national statistics



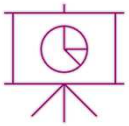
Possible data sources

Governmental / national statistics

Likely to be the main source of information

Trade bodies / representative organisation

Could be useful, especially for data on customers/meals served



Private market research

If you have no idea what data is available or where to start, these could be useful

Examples include:

- Euromonitor international
- Mintel
- GlobalData
- Statista

Downsides:

- Often for specific subsectors only
- Often very expensive to access

Possible data sources

- **National datasets**
  - Schools/educational institutions (Education department?)
  - Hospitals/care homes (Health department?)
  - Prisons/military (Defence department?)
  - Markets, restaurants, cafés, canteens etc. (Licensing procedure? Food safety databases? Does this miss informal economy?)

What sorts of national data do you have available to you?

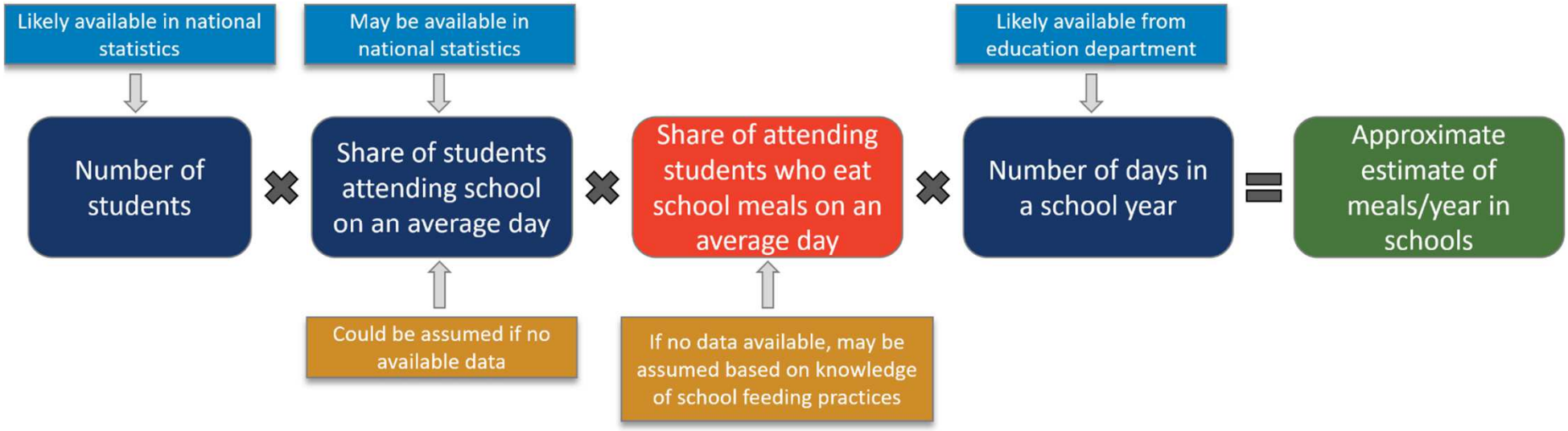
Identify data on the size of subsectors

Generating new food-service data

- **Use surveys to generate new information on eating-out habits**
  - May already be covered in dietary, health and nutrition surveys [e.g.]
  - Could include questions as part of a food waste diary or other food-based survey:
    - E.g. 'in a typical week, how many meals do you/your family eat at the following food service locations:
      - *Restaurants*
      - *Fast food establishments*
      - *Pubs/bars*
      - *Hotels*
      - *Informal/street food vendors*
      - *Etc.*

Generating new food service data

- **Use assumptions or proxy data from similar countries**



- **Fewer assumptions is better…**

  … sensitivity testing your assumptions is advisable

Food service sampling

How long to measure for?

- **Shorter duration of measurement is cheaper…**
- **But only gives a snapshot:**
  - Less accurate
  - Less useful for the business for developing strategy
  - Requires more kitchens / premises / businesses to be sampled
- **A week would be a minimum, given variation through the week**
- **Seasonality likely to be very important in some setting (e.g., where tourism influences demand)**
  - Need multiple sampling throughout the year

Table 3. Aspects covered in previous food waste quantification studies.

Kitchen type	Country	Units (n)	Duration	Waste (%)	Waste/portion (g)	Source
Hospital	UK	1	28 days	>40	-	Barton *et al.* (2000)
Schools & restaurants	Sweden	4	2 days	20	92.5	Engström & Carlsson-Kanyama (2014)
Catering	Egypt	-	-	23-51	126,131,166	El-Mobaidh *et al.* (2006)
Hospital	UK	3	2 days	19-66	-	Sonnino & McWilliam (2011)
University	Portugal	1	4 weeks	24	280	Ferreira *et al.* (2013)
Food service sector	Finland	72	1 day – 1 week	8-27	-	Katajajuuri *et al* (2014)
Preschool	USA	1	5 days	45.3	210	Byker *et al.* (2014)
Schools	Portugal	21	1 month	27.3	49.5	Martins *et al.* (2014)
Hospital	Portugal	1	8 weeks	35	953	Dias-Ferreira *et al.* (2015)
Schools	Italy	3	92+33 days	15.31	-	Falasconi *et al.* (2015)
Schools & restaurants	Switzerland	2	5 days	7.69 & 10.73	86 & 91	Betz *et al.* (2015)
Food service sector	Finland	51	5 days	19-27	58-189	Silvennoinen *et al.* (2015)
Hotel	Malaysia	1	1 week	-	1100	Papargyropoulou *et al.* (2016)
University	South Africa	9	21 days	-	555	Painter *et al.* (2016)
Preschools	Sweden	4	2 weeks	-	145	Hansson (2016)
Schools	China	6	1 day/unit	21	130	Liu *et al.* (2016)
Public sector	Sweden	30	3 months	23 (13-34)	75 (33-131)	Eriksson *et al.* (2017)
Hotel	Slovenia	1	63 days	-	15.2	Juvan *et al.* (2017)
Schools	Italy	4-5	5-10 days	27	-	Boschini *et al.* (2018)
Schools	Italy	1	12 days	-	151	Lagorio *et al.* (2018)
University	Qatar	3	40 days	~50	980, 757	Abdelaal *et al.* (2019)
University	China	6	2-3 days	-	73.7	Wu *et al.* (2019)
Hospitals	Saudi Arabia	1	3 weeks	-	412	Alharbi *et al.* (2020)
Hospitals	Sweden	20	2013-2019	-	111	Eriksson *et al.* (2020)
Schools	Italy	78	740 days	-	160	Boschini *et al.* (2020)
Catering	Germany	239	4 years	-	74-280	Leverenz *et al.* (2020)

Christopher Malefors, Thesis: https://susfood-db-era.net/main/sites/default/files/2021-04/malefors_c_210216.pdf

How many sampling units to sample?

Variation in normalised food waste between the sampling units

$$\text{Sample size} \approx \left(2 \times \frac{\text{Standard Deviation}}{\text{Desired 95\% confidence interval}}\right)^2$$

More accuracy (smaller confidence interval) => larger sample size

$$\text{Sample size} \approx \left(2 \times \frac{\text{Standard Deviation}/\text{Mean}}{\text{Desired 95\% confidence interval}/\text{Mean}}\right)^2$$

Standard deviation / mean ≈ ???

Desired 95% CI / mean ≈ ???

- Use <u>normalised</u> values for st. dev. and mean, i.e. those used for scaling
- Resulting sample size will be the number of sampling units
- For priority sub-sectors, aim for ±10%, for others ±20%

Variation in food waste for example 1

Sector	Kitchens (n)	Mean (%)	Std. Dev. (%)
Canteens	5	29	5
Care homes	8	26	14
Hospitals	-	-	-
Hotels	-	-	-
Preschools	148	26	13
Primary schools	226	19	6
Restaurants	9	24	6
Secondary schools	35	20	6
Total	431	22	10

$$\frac{\text{Standard Deviation}}{\text{Mean}} = \frac{6\%}{19\%} = 0.32$$

- Analysis of existing data
- Data presented as **food waste as percentage of food served**
- Standard deviation between different kitchens
- Sampling unit = kitchen

Christopher Malefors, Thesis: https://susfood-db-era.net/main/sites/default/files/2021-04/malefors_c_210216.pdf

Example calculation 1

- For primary schools
- Sampling unit = kitchen
- Data expressed as % of food served
- Priority sector

$$\text{Sample size} \approx \left(2 \times \frac{\text{Standard Deviation}/\text{Mean}}{\text{Desired 95\% confidence interval}/\text{Mean}}\right)^2$$

Standard deviation / mean ≈ 0.32

Desired 95% CI / mean ≈ 0.1 (10%)

$$\approx \left(2 \times \frac{0.32}{0.1}\right)^2 \approx 41 \text{ kitchens}$$

- Need to be randomly selected to ensure representative

Variation in food waste for example 2

Sector	Kitchens (n)	Mean (g)	Std. Dev. (g)
Canteens	230	84	74
Care homes	49	150	120
Hospitals	16	110	33
Hotels	83	140	82
Preschools	193	95	56
Primary schools	322	66	29
Restaurants	15	230	94
Secondary schools	46	89	34
Total	954	91	69

$$\frac{\text{Standard Deviation}}{\text{Mean}} = \frac{29 \text{ grams}}{66 \text{ grams}} = 0.44$$

- Analysis of existing data
- Data presented as **weight of food waste per portion**
- Standard deviation between different kitchens
- Sampling unit = still the kitchen

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Example calculation 2

- For primary schools
- Sampling unit = kitchen
- Data expressed **as food waste per meal**
- Priority sector

$$\text{Sample size} \approx \left(2 \times \frac{\text{Standard Deviation}/\text{Mean}}{\text{Desired 95\% confidence interval}/\text{Mean}}\right)^2$$

Standard deviation / mean ≈ **0.44**

Desired 95% CI / mean ≈ 0.1 (10%)

$$\approx \left(2 \times \frac{\cancel{0.32}0.44}{0.1}\right)^2 \approx \cancel{41 \text{ kitchens}}\ 77 \text{ kitchens}$$

- Sample size sensitive to how data is normalised

Sample sizes

- **Ideal case:**
  - Work with existing data, including mean and standard deviation, in order to calculate sample size *for each subsector included*
  - Greater precision needed in high-priority subsectors (±10%), less precision needed for lower priority (±20%)

- **If no data is available, or subsectors lack information: start with approximately 30 establishments per subsector**

- **But… … depends on how you plan on collecting data**