Food
Loss + Waste
PROTOCOL

VERSION 1.0

Food Loss and Waste Accounting and Reporting Standard

The Consumer Goods FORUM

FUSIONS

UNEP

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WORLD RESOURCES INSTITUTE

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Foreword

Did you know that an estimated one-third of all food is lost or wasted as it moves from where it is produced to where it is eaten?

This has major economic, social, and environmental impacts, causing as much as $940 billion per year in economic losses and exacerbating food insecurity and malnutrition. The associated cost goes well beyond money: lost and wasted food consumes a quarter of all water used by agriculture annually, requires cropland area the size of China, and generates an estimated 8 percent of global greenhouse gas emissions. In fact, if lost and wasted food were a country, it would be the third-largest greenhouse gas emitter on the planet behind China and the United States.

Reducing food loss and waste therefore can be a triple win: (1) it saves money for farmers, companies, and households; (2) wasting less becomes an opportunity to feed more; and (3) reductions ease the pressure on water, land, and the climate.

Cutting food loss and waste can also help countries and companies meet international and corporate agreements, including the Paris Agreement on climate change. The Sustainable Development Goals—specifically SDG Target 12.3—call for cutting per capita global food waste in half at retail and consumer levels and reducing food losses along production and supply chains (including post-harvest losses) by 2030.

We have all heard the business adage: "what gets measured gets managed." We believe this applies to food loss and waste as well. That is why our institutions, which comprise the Food Loss & Waste Protocol partners, developed the global *Food Loss and Waste Accounting and Reporting Standard (FLW Standard)* to provide requirements and guidance for governments, companies, and other entities.

By developing inventories in conformance with the *FLW Standard*, countries, cities, companies, and others will be able to better understand how much food loss and waste is generated and where it goes. Such information is critical for developing effective reduction strategies and monitoring progress over time. Ultimately, this can bring economic, environmental, food security, and nutritional benefits.

We hope the *FLW Standard* inspires and facilitates your efforts to measure so you can successfully manage.

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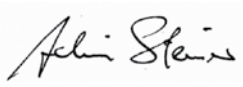

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About the FLW Protocol

The Food Loss & Waste Protocol (FLW Protocol) is a multi-stakeholder partnership, which has developed the global *Food Loss and Waste Accounting and Reporting Standard (*or *FLW Standard)* for quantifying food and/or associated inedible parts removed from the food supply chain (referred to commonly as "food loss and waste" and abbreviated as FLW). Launched in 2013, the mission of the FLW Protocol is to develop an internationally accepted FLW accounting and reporting standard and associated tools, and to promote their adoption so entities are better informed and motivated to take appropriate steps to minimize FLW.

The FLW Protocol followed a broad, inclusive, consensus-based, multi-stakeholder process to develop this standard. Participants included government agencies, intergovernmental organizations, non-governmental organizations, businesses, and academic institutions from around the world.

A Steering Committee of expert institutions provided technical input, strategic direction, and quality control throughout the standard's development. The Steering Committee consists of The Consumer Goods Forum (CGF), Food and Agriculture Organization of the United Nations (FAO), EU-funded FUSIONS project,[1] United Nations Environment Programme (UNEP), World Business Council for Sustainable Development (WBCSD), WRAP (The Waste and Resources Action Programme), and World Resources Institute (WRI), which also serves as Secretariat leading the drafting and review process.

The FLW Protocol complements efforts by Save Food—including Think Eat Save—led by FAO, UNEP, and other partners. It also contributes to private-sector efforts led by The Consumer Goods Forum, FoodDrinkEurope's "Every Crumb Counts," Courtauld Commitment 2025 in the United Kingdom, and the Food Waste Reduction Alliance in the United States. In addition, it builds upon regional approaches to quantification, such as that developed by the FUSIONS project and others.

About Development of the *FLW Standard*

The FLW Protocol Steering Committee began developing the *FLW Standard* in early 2014. Two Technical Working Groups contributed to the first draft of the standard, which was coordinated by WRI. One Technical Working Group focused on FLW quantification in the upstream portions of the food supply chain (from harvest to processing), and the other Technical Working Group focused on FLW quantification in the downstream portions of the food supply chain (from processing to consumption). Together, these two Technical Working Groups comprised more than 80 experts from a diversity of businesses, government agencies, intergovernmental agencies, non-governmental organizations, and academic institutions from more than 25 countries and six continents.

In March 2015, the Secretariat made the draft *FLW Standard* available for review by an External Review Group, a suite of pilot testers, and the general public. The review and pilot testing provided feedback on the content, practicality, and usability of the standard. In total, the Secretariat gathered feedback from more than 200 external stakeholders representing companies, national and city governments, intergovernmental agencies, non-governmental organizations, and academic institutions from around the world (see Recognitions). This feedback was incorporated into a revised draft, which was reviewed by the Steering Committee for final editing and approval.

Guide to the Structure of this Document

The *FLW Standard* provides requirements for countries, companies, and other entities to use in accounting for and reporting on FLW. It also includes guidance, resources, and examples to assist in the use of the standard. A separate Executive Summary highlights the standard's most important features.

The standard is divided into three parts. Part I includes Chapters 1–5, which cover: an overview of the purpose and intended use of the *FLW Standard* (1), definition of terms and applications (2), the possible goals of quantifying FLW (3), steps to guide preparation of an FLW inventory and a summary of the standard's requirements (4), and principles underlying accounting and reporting (5).

Parts II and III (Chapters 6–14) provide more detail about the requirements in the standard and guidance on implementing them. More specifically:

- Part II (Chapters 6 and 7) provides detailed guidance on requirements to account for and define "what" is being quantified (the scope of the FLW inventory), and "how" it is being quantified (the method).
- Part III (Chapters 8–14) provides guidance about additional requirements of the standard as well as recommendations. It covers: collecting, calculating, and analyzing data (8), assessing uncertainty (9), coordinating the analysis of multiple FLW inventories (10), recording the causes of FLW (11), review and assurance processes (12), reporting (13), and target setting (14).

A set of Appendices provides further information on details related to analyzing and managing data. An important companion to the standard is the *Guidance on FLW Quantification Methods*, which is available online at www.flwprotocol.org. A sample reporting template, as well as an FLW Quantification Method Ranking Tool, are also available online at www.flwprotocol.org.

The Glossary provides definitions and commentary for important terms used throughout the *FLW Standard*.

PART I
OVERVIEW

The chapters in Part I cover the purpose and vision of the *FLW Standard* (Chapter 1), definition of terms used in the standard and their applications (Chapter 2), possible goals of quantifying FLW (Chapter 3), steps that guide preparation of an FLW inventory and a summary of the standard's requirements (Chapter 4), and principles underlying accounting and reporting (Chapter 5).

1. Introduction

1.1 Purpose and Vision

The *Food Loss and Waste Accounting and Reporting Standard* (or *FLW Standard*) is a global standard that provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food supply chain—commonly referred to as "food loss and waste" (FLW). Using the standard enables countries, cities, companies, and other entities to develop inventories of how much FLW is generated and where it goes. These inventories can underpin, inform, and focus strategies for minimizing FLW. Minimizing FLW can provide economic benefits, enhance food security, improve natural resource use efficiency, and reduce environmental impacts.

The purpose of the *FLW Standard* is to facilitate the quantification of FLW (what to measure and how to measure it) and encourage consistency and transparency of the reported data. The standard enables the consistent quantification of baselines and tracking of progress toward Target 12.3[2] of the United Nations Sustainable Development Goals as well as other targets.

The standard is designed to be practical so that entities of all kinds can develop an FLW inventory based on their particular quantification goals. Using the terminology and requirements provided by the standard ensures international consistency, enables comprehensiveness, and supports transparent disclosure of FLW inventories both within and among entities. Quantifying FLW is an important foundation for reduction efforts that can deliver a diverse array of benefits—from reducing costs associated with over-purchase and disposal, to avoiding greenhouse gas emissions, or supporting efforts to eliminate hunger. Entities that prepare inventories in conformance with the *FLW Standard* will be better informed about how much FLW is generated and where it ends up, and therefore better equipped to take action.

1.2 The Need for an Accounting and Reporting Standard

A significant share of food grown for human consumption is never eaten. The Food and Agriculture Organization of the United Nations (FAO) estimates that a third, by weight, of all food produced in the world was lost or wasted in 2009.[3]

This level of inefficiency has significant economic, social, and environmental impacts. For example, it results in approximately US$940 billion per year in economic losses, according to FAO estimates.[4] It exacerbates food insecurity. And the amount of food lost or wasted translates into about a quarter of all water used by agriculture,[5] requires cropland equivalent to an area the size of China,[6] and is responsible for an estimated 8 percent of global greenhouse gas emissions.[7]

In addition, the inedible parts associated with food (e.g., bones, rinds, pits/stones) can take up space in landfills, and contribute to greenhouse gas emissions during decomposition. These inedible parts represent a form of natural resource inefficiency (to the degree that behavioral or technological changes could transform some of them into food or other products of human benefit). This standard is relevant to both food and the associated inedible parts.

Many countries, cities, companies, and other entities currently lack sufficient insight into how much, why, and where food and/or associated inedible parts are removed from the food supply chain. This makes it difficult to develop strategies and prioritize actions to prevent FLW, and to identify the most productive use of the FLW that does arise. In short, it is challenging to manage what you do not measure. Moreover, what's considered "food loss and waste" varies widely and, without a consistent set of definitions or an accounting and reporting framework, it is difficult to compare data within or among entities over time and draw useful conclusions.

This standard addresses these challenges by providing accounting and reporting requirements that can be used consistently by entities around the world. It also includes universally applicable definitions for describing the components of "food loss and waste" included in an inventory. Definitions of food loss and waste as used in the *FLW Standard* are discussed in Sections 2.2 and 2.3.

1.3 How the Standard Can be Used

The standard is voluntary and designed for users of all types and sizes, across all economic sectors, and in any country. The term "entity" is used to denote any party that might be interested in developing an FLW inventory. Entities may include intergovernmental agencies, governments (e.g., of nations, states, cities), industry associations, companies, and agricultural producers, among others.

Given this diverse audience, why and how an entity uses the *FLW Standard* will vary. Before developing an FLW inventory, an entity should clearly articulate why it wants to quantify FLW. Its rationale may focus on preventing FLW from occurring in the first place as well as diverting it to better uses where value can be created or recovered. Once an entity chooses to quantify FLW, the standard may be used for various purposes, including to:

- produce an FLW inventory to inform an entity's own internal decision-making;
- report on results of an FLW inventory to comply with a government, industry association, or other third-party FLW-reduction effort; and/or
- inform development of an FLW policy, initiative, or program that customizes its own guidance built on the *FLW Standard*.

The standard is designed to reflect practical data and resource constraints, as well as the multiple possible reasons for quantifying FLW. As such, while the standard is firm on the definitions for describing the scope of an FLW inventory and the requirements for accounting and reporting results, it is flexible in allowing users to choose which particular scope is most appropriate for their FLW inventory. For example, users choose whether to quantify both food and associated inedible parts removed from the food supply chain, only food, or only associated inedible parts (see Figure 2.1 in Chapter 2). The choice they make is a function of their goals for quantifying FLW.

The FLW Protocol itself will not rank or rate an entity's performance. However, external organizations may develop prescriptive accounting or reporting requirements—based on the *FLW Standard*—and may rank or rate entities.[8]

The standard is accompanied by a spreadsheet that presents a sample FLW inventory reporting form (www.flwprotocol.org). However, an entity may use any format to report FLW provided it contains all the reporting requirements, which are summarized in Section 4.2.

1.4 Guiding Principles and Design of the Standard

Several guiding principles served as a foundation for the design and development of the *FLW Standard*:

- *Use a multi-stakeholder process*. Development of the *FLW Standard* was inclusive and global, involving representation from governments, intergovernmental agencies, civil society organizations, businesses, and academic institutions from around the world.
- *Build on existing initiatives*. Development of the *FLW Standard* proactively engaged entities that had already created or were in the process of creating FLW quantification methods for particular geographies or specific stages of the food supply chain, in order to avoid "reinvention of the wheel" and to facilitate global standardization.
- *Keep the scope broad*. The *FLW Standard* is relevant to FLW that occurs anywhere from the point of harvest[9] to the point of consumption and is therefore appropriate for all types of users.
- *Meet user needs*. The *FLW Standard* provides guidance and recommendations about quantification methods and data sources that strive to be user-friendly, practical, and yield meaningful results.
- *Avoid letting "the perfect become the enemy of the good."* The *FLW Standard* recognizes that users do not necessarily need complete or precise quantification in order to begin taking steps to minimize FLW.

- *Be "firm yet flexible."* In order to be globally applicable, the *FLW Standard* is firm on aspects such as definitions of the possible components of FLW and on accounting and reporting principles. At the same time, it is flexible on aspects such as quantification methods because data availability and measurement capacity can vary greatly among entities.

These guiding principles led to three design features of the *FLW Standard*, namely: it allows for modular definitions, it allows for the use of diverse quantification options, and it is expected to evolve over time.

MODULAR DEFINITIONS OF FLW

The *FLW Standard* is designed to allow for the fact that different organizations will have different reasons for quantifying FLW. These different goals lead to (or government regulations may even explicitly state) different definitions of what constitutes FLW. The *FLW Standard*, therefore, defines the possible components of FLW in terms of the possible material types (i.e., food and/or associated inedible parts) and destinations (where material removed from the food supply chain is directed; see Figure 2.1). It allows an entity to select which combination of material types and destinations it considers to be "food loss and waste," in accordance with the entity's stated goals.

For example, an entity that seeks to meet targets aimed at improving food security may define FLW only in terms of the food (not the associated inedible parts) that leaves a particular food supply chain, regardless of the ultimate destination. Another entity that seeks to meet targets aimed at reducing greenhouse gas emissions from waste management operations by limiting the amount of FLW that goes to landfills may define FLW as both food and associated inedible parts, but only one destination would be relevant—in this example, landfill.

The modular approach of the *FLW Standard*, outlined above, allows for this flexibility. That is, an entity may choose whether it quantifies both food and associated inedible parts removed from the food supply chain, only food, or only associated inedible parts, as well as which destinations will be included within its scope. The *FLW Standard* thus provides globally applicable definitions of possible FLW components, while the entity itself defines which of these components are to be included in its FLW inventory, depending on its goals and operating context (e.g., requirements of voluntary or mandatory FLW reduction targets or programs). See Chapter 6 for more detail.

DIVERSE QUANTIFICATION OPTIONS

In many cases, an entity will face a choice regarding how to quantify FLW. Often, the options present a tradeoff between accuracy and completeness on the one hand, and the cost of conducting the quantification on the other. The *FLW Standard* allows for a range of methods, with varying levels of accuracy and completeness, to meet the needs of diverse entities with varying resources (e.g., technical, financial) and data availability, rather than prescribing a single quantification method. The standard provides guidance about which methodological options are likely to result in FLW inventories with a higher degree of accuracy. Some entities will choose options that yield more accurate data (for example, to quantify and report base year FLW and progress toward reducing FLW over time). Others will opt for methods that simply provide a general understanding of how much FLW is generated. To ensure transparency, the *FLW Standard* requires entities to report the quantification method used and describe the level of uncertainty.

A lack of "perfect" data or capacity to utilize the most advanced quantification methods should not preclude an entity from starting the process of improving understanding of its FLW and taking action. A simple spreadsheet (FLW Quantification Method Ranking Tool at www.flwprotocol.org) is available to help users consider different quantification methods and guide decisions, based on important criteria such as desired level of accuracy and access to the physical FLW being quantified.

EVOLVING DESIGN

This standard is the first output of the FLW Protocol, a global multi-stakeholder partnership. The *FLW Standard* was developed via a multi-stakeholder process during 2014 and 2015. It is "Version 1.0" because it will continue to improve over time as quantification methods, data, and user needs evolve. Subsequent versions will incorporate these improvements.

2. Definition of Terms and Applications

This chapter defines some of the principal terms used in the *FLW Standard* and explains how users can apply them as they develop an FLW inventory. The Glossary at the end of the document provides a summary table of definitions and commentary for important terms in the standard.

2.1 Standard Terminology: Shall, Should, and May

The *FLW Standard* uses precise language to indicate which provisions of the standard are requirements, which are recommendations, and which are permissible or allowable, meaning that users may choose to follow them.

The term **"shall"** is used throughout this standard to indicate what is *required* in order for an FLW inventory to be in conformance with the *FLW Standard*. The term **"should"** is used to indicate what is a *recommendation* but not a requirement. The term **"may"** is used to indicate a provision that is permissible or allowable.

Within this document, the term "required" or "requirements" is used to refer to "shall" statements given elsewhere in the standard. Since use of this standard is voluntary, these requirements refer only to what must be followed in order for an inventory to be in conformance with the *FLW Standard*. The terms "needs," "can," and "cannot" are used to provide guidance on implementing a requirement or to indicate when an action is or is not possible.

2.2 Material Types and Possible Destinations

The *FLW Standard* requires users to account for (quantify) two components: material type and destination.

Material type refers to the material that is removed from the food supply chain (i.e., food and/or associated inedible parts) and quantified in an FLW inventory. Depending on the goals of quantification, an entity may account for:

- Both food and associated inedible parts
- Food only, or
- Associated inedible parts only

Box 2.1 | Defining Food and Inedible Parts

Food:[a] Any substance—whether processed, semi-processed, or raw—that is intended for human consumption. "Food" includes drink, and any substance that has been used in the manufacture, preparation, or treatment of food. "Food" also includes material that has spoiled and is therefore no longer fit for human consumption. It does not include cosmetics, tobacco, or substances used only as drugs. It does not include processing agents used along the food supply chain, for example, water to clean or cook raw materials in factories or at home.

Inedible parts: Components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans. Examples of inedible parts associated with food could include bones, rinds, and pits/stones. "Inedible parts" do not include packaging. What is considered inedible varies among users (e.g., chicken feet are consumed in some food supply chains but not others), changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography.

[a]Adapted from Codex Alimentarius Commission (2013).

One way to understand the distinction between material types is to consider a whole banana. In the context of a fresh banana supply chain, the flesh of the banana will often be defined as food (because it is intended for human consumption) whereas the banana skin is the associated inedible part (because in many cultures it is not intended for human consumption). Material types are further defined in Box 2.1.

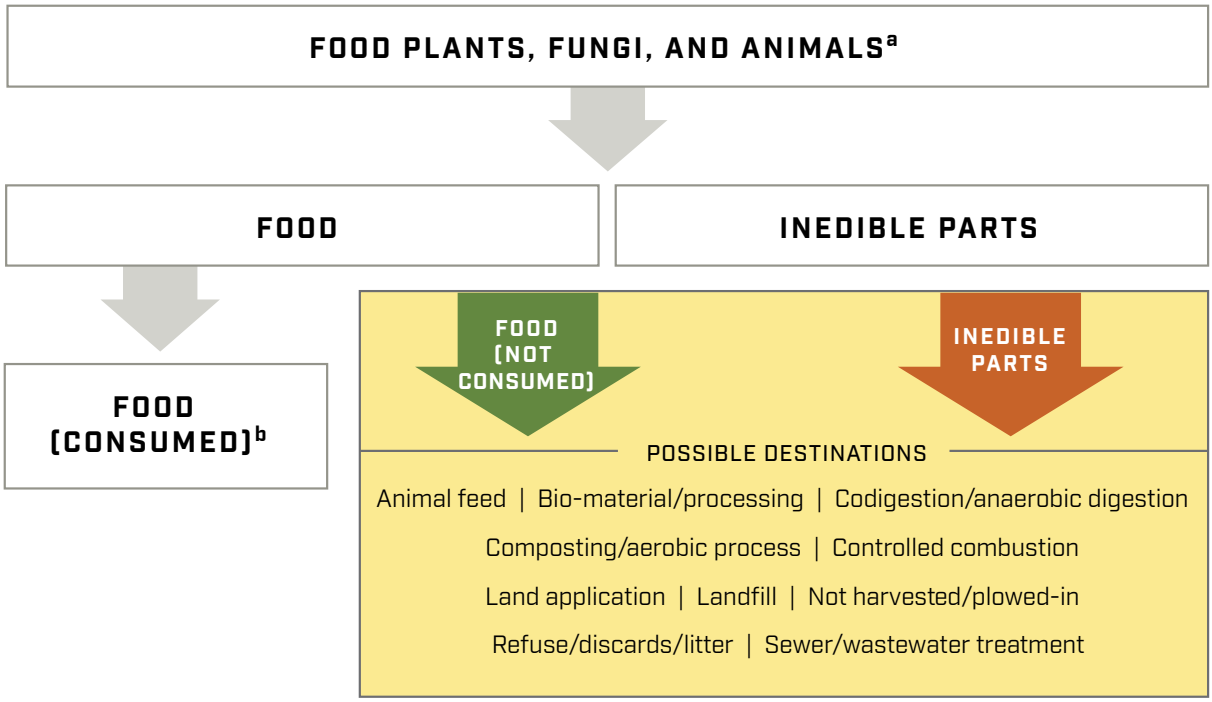
Destination refers to where material removed from the food supply chain is directed. There is a range of possible destinations, which represent a range of alternative uses and potential value. The 10 categories used in the *FLW Standard* are:

- Animal feed
- Bio-based materials/biochemical processing
- Codigestion/anaerobic digestion
- Composting/aerobic processes
- Controlled combustion
- Land application
- Landfill
- Not harvested/plowed in
- Refuse/discards/litter
- Sewer/wastewater treatment

Chapter 6 provides more detail about the material types, defines the destinations, lists the requirements, and provides guidance about accounting and reporting on them.

Figure 2.1 is a simplified depiction of material types and possible destinations. People harvest, slaughter and/or hunt food plants, fungi, and animals. A portion of this is "food," or substances (whether processed, semi-processed, or raw) intended for human consumption. The rest is "inedible parts," or substances associated with a food that—in a particular food supply chain—are not

Figure 2.1 | Material Types and Possible Destinations Under the FLW Standard



[a] Intended for human consumption (i.e.., excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use)
[b] At some point in the food supply chain (including surplus food redistributed to people and consumed)
Source: Adapted from FAO. 2014. Definitional Framework of Food Loss. Working paper of the Global Initiative on Food Loss and Waste Reduction. Rome, Italy: FAO.

intended for human consumption. These include, for example, bones, rinds, and pits/stones (Figure 2.1, red [right] arrow).[10] Any food that is not eventually directly consumed by people is considered "removed from the food supply chain" (Figure 2.1, green [left] arrow).

The green (left) and red (right) arrows represent the two possible material types in an FLW inventory. These material types go to one or more possible destinations (listed within the yellow shaded box) once they are removed from the food supply chain, traveling to these destinations through several "paths," which are described further in Section 6.5.

The *FLW Standard* provides accounting and reporting requirements and guidance for everything within the yellow shaded box in Figure 2.1 (i.e., everything removed from the food supply chain). Conversely, the *FLW Standard* is not focused on material that does not enter the yellow (shaded) box because that material is not removed from the food supply chain.

Which particular material type(s) and destination(s) are included in an FLW inventory will be a function of the entity's FLW goals, which might be defined by a company policy, industry initiative, government regulation, intergovernmental target, or other source. Section 6.8 provides examples of how an entity's goals determine the selection of the material type and destination.

2.3 Definitions of "Loss and Waste"

The *FLW Standard* does not specify precisely which set of destinations comprises "loss and waste." Rather, it gives globally consistent and applicable definitions of the *possible* destinations for food and/or associated inedible parts removed from the food supply chain.

The combination of destinations that is referred to as "loss and waste" in a particular situation will be determined by factors external to the *FLW Standard* such as voluntary corporate targets, industry association commitments, national regulation, and targets set by political intergovernmental bodies such as the European Union or United Nations. The term "destination," as defined by the *FLW Standard*, represents where the material removed from the food supply chain is directed, and is independent of what might be considered "loss," "waste," "wastage," or other related terms according to local legislation or other external policies.

Because the terms "food loss" and "food waste" are commonly used to describe aspects of food and/or associated inedible parts removed from the food supply chain, the *FLW Standard* uses them for the sake of simplicity. However, it is users of the standard who select and report on the combination of "material type" and "destination" that best describes what is quantified in their FLW inventories. It is, therefore, users of the standard who decide what makes up the particular definition of "food loss" or "food waste" on which they report, based on their quantification goals.

2.4 How the Standard Addresses the Environmental, Nutritional, or Financial Implications of FLW

Users of the *FLW Standard* **shall** account for the physical amount of FLW, expressed as weight.[11] However, some users may wish to describe and convey the scale and relevance of FLW in other terms or units of measurement, in addition to weight. While doing so is not required by the standard, Appendix D of this standard provides an introductory overview to expressing FLW in terms of environmental impact, nutritional content, or financial implications.

2.5 How the Standard Applies to Certain Components of the Food Supply Chain

Table 2.1 clarifies whether or not the standard applies to different components of the food supply chain.

Table 2.1 | Application of the Standard to Components in the Food Chain

DOES THE STANDARD APPLY TO:	ANSWER	EXPLANATION
Food?	Yes	The quantification goals of an entity will dictate which material type an FLW inventory accounts and reports. The material type selected for quantification may be only food removed from the food supply chain, only associated inedible parts, or both food and associated inedible parts removed from the food supply chain
Inedible parts?	Yes	
Drinks?	Yes	The definition of food used for the standard includes drinks
Food rescued and secondary markets for food?	No	Given that the standard is focused on material no longer in the food supply chain, food that is transferred from one part of the food supply chain to another but still used for human consumption is outside the scope of the *FLW Standard* In order to meet its particular goals, an entity may nonetheless choose to quantify and report the amount of safe and wholesome food rescued to feed people. However, users of the *FLW Standard* shall keep data about food rescued separate from their FLW inventory results Given the importance of food rescue as a channel for food still fit for human consumption (also referred to as food recovery, redistribution, or donation), Appendix E of the standard includes related guidance on quantifying and reporting the weight of rescued food When food and/or associated inedible parts at food banks or charities are removed from the food supply chain (i.e., not ultimately consumed by people), these entities should use the *FLW Standard* to account and record the amount of FLW
Packaging?	No	The definition of FLW does not include packaging, such as boxes, wrapping, or plastic containers.[a] Therefore, users shall exclude the weight of any packaging. Section 8.3 provides guidance on how to exclude the weight of packaging from the amount of FLW
Losses that take place pre-harvest?	No	The *FLW Standard* (Version 1.0) does not include provisions for how to quantify losses that occur pre-harvest.[b] A separate process would be needed to develop a pre-harvest standard and/or guidance, which may be addressed in future work by the FLW Protocol While some guidance included in the *FLW Standard* may be relevant to quantifying losses pre-harvest, this standard has neither been developed with this in mind nor has the quantification of pre-harvest losses been tested during the development process. Moreover, pre-harvest losses are different from losses that occur at harvest or later, both in terms of how they are manifested and how they are quantified (see Section 6.7., "Pre-harvest losses") Quantifying and understanding losses that take place pre-harvest, however, can be relevant to increasing the availability of food for human consumption. Furthermore, what happens pre-harvest, such as weather-related damage to crops, may contribute to FLW at harvest and beyond. This standard recommends that users collect and record information on causes of FLW, which might therefore capture factors that take place pre-harvest In order to meet its particular goals, an entity may nonetheless choose to quantify pre-harvest losses. However, users of the *FLW Standard* shall not include data on pre-harvest losses in their FLW inventory results

Table 2.1 | Application of the Standard to Components in the Food Chain (continued)

DOES THE STANDARD APPLY TO:	ANSWER	EXPLANATION
Agricultural raw materials intended for purposes other than food?	No	While the standard may be relevant to agricultural raw materials grown or used for purposes other than food (e.g., as animal feed, tobacco, bio-fuels, cosmetics), it has been neither developed nor tested with these purposes in mind In situations where the user does not know the actual intended use of agricultural raw materials, the *FLW Standard* provides guidance in Section 6.4., "Guidance: When the ultimate purpose of material is not known, or changes"

[a] Edible packaging would be considered food for the purpose of the *FLW Standard* because it is intended for human consumption

[b] For the purpose of the *FLW Standard*, "pre-harvest" refers to the stage in food production that occurs before a raw material for food is ready for harvest or slaughter (see Section 6.7., "Starting point of the food supply chain")

2.6 Using the Standard to Make Comparisons among Entities

An entity that prepares an FLW inventory in conformance with the *FLW Standard* may be able to make direct comparisons with another inventory provided that both inventories are based on the same inventory scope (i.e., timeframe, material type, destinations, and boundary) as defined and described in Chapter 6. Even when using the same scope, however, entities may use different approaches to quantification and different assumptions that affect the accuracy and completeness of an inventory's results and therefore its comparability. It is important to take these factors into account when evaluating one FLW inventory relative to another and to use caution when drawing conclusions across inventory results.

To maximize the comparability of FLW inventories, it is incumbent upon those responsible for creating FLW reduction goals, targets, regulations, and/or reporting programs to clearly specify the relevant FLW scope and quantification methods, and to require that inventory results are accounted for and reported according to the requirements of the *FLW Standard* (summarized in Section 4.2). Chapter 10 provides guidance for entities such as national governments or industry associations seeking to coordinate the development and calculation of multiple FLW inventories for further analysis. The development of sector-specific FLW accounting and reporting guidance would provide additional consistency across FLW inventory results (see Box 2.2).

Box 2.2 | Considerations for Developing Sector-specific Guidance

The *FLW Standard* (Version 1.0) is designed for any type of entity and user, and is not sector-specific. However, the development of sector-specific requirements, implementation guidance, and tools could drive more consistent FLW quantification, reporting, and performance-tracking practices for a particular sector. Helpful information might include guidance on interpreting the standard for a specific sector, guidance and tools for calculating FLW from sector-specific activities, recommended performance metrics, suggested data sources, and relevant conversion factors, where appropriate. Sectors are encouraged to use an inclusive multi-stakeholder process if developing specific requirements or guidance. This will help to ensure broad acceptance as well as increased consistency and credibility.

3. Goals of Quantifying FLW

Before developing an FLW inventory in conformance with the *FLW Standard*, an entity should clearly articulate why it wants to quantify FLW. The rationale or goal for quantifying FLW influences the scope of the inventory and the degree of accuracy needed.

An entity may seek to reduce FLW or divert it to higher-value destinations to achieve one or more of the following goals:

- ***Food security.*** Reducing FLW increases the amount of food that remains available for human consumption and thereby improves food security. There may also be options to transform what is considered "inedible parts" today into a food source in the future. Food security can be a highly relevant goal for humanitarian and political reasons.
- ***Economic outcomes.*** Reducing or diverting FLW reduces the loss of economic value in the food supply chain and thereby improves economic or financial performance. FLW represents resources—labor, capital, energy, seeds, water—to grow, harvest, store, transport, market, or purchase food and its associated inedible parts that ultimately exit the food supply chain. This may jeopardize the availability of these resources and increase their price. FLW is a cost that ultimately does not result in food consumed. This financial loss is borne across the food supply chain, from food producers to processors, retailers, and consumers. Moreover, in some circumstances, an entity can incur direct financial costs when disposing of FLW (e.g., tipping fees for FLW that is disposed in a landfill, payments to a waste management company to collect FLW).
- ***Environmental sustainability.*** Reducing FLW improves local, regional, or global environmental sustainability by lowering greenhouse gas emissions, and optimizing water consumption, land area cultivated, and fertilizer and pesticide usage associated with the agricultural system. This improved environmental performance benefits efforts to mitigate climate change, conserve freshwater resources, protect biodiversity, and reduce pollution.

An entity should clearly articulate why it wants to quantify FLW. The rationale or goal for quantifying FLW influences the scope of the inventory and the degree of accuracy needed.

3.1 Mandatory and Voluntary Goals

In some circumstances, an entity may adopt an FLW reduction goal in response to a mandatory policy or regulation established by a government or other authority. For example, the State of Massachusetts in the United States limits companies to sending just one ton of organic material per week to a solid waste disposal facility.[12]

In other circumstances, an entity may adopt an FLW reduction goal as part of a voluntary commitment undertaken either alone or as part of a consortium. The United Nations, for example, has set a voluntary target as part of the Sustainable Development Goals (SDGs) (Box 3.1).[13] Likewise, a company might set a corporate FLW reduction goal for itself or its value chain, or an industry association might set a goal for its members. In June 2015, The Consumer Goods Forum adopted a target of halving food waste within its members' retail and manufacturing operations by 2025 (relative to a 2016 baseline) as well as contributing to the UN SDGs by 2030.[14]

Once a clear goal (or goals) is defined, an entity will need to quantify FLW in order to facilitate planning, implementation, and monitoring activities designed to achieve the goal(s). Quantification may be undertaken to:

- establish a base year FLW quantity against which targets can be set and future progress can be compared;
- set a quantified FLW reduction target;
- track progress relative to the target over time;
- compare (or be compared) to other entities for the sake of benchmarking performance;
- identify how much FLW goes to different destinations;
- estimate the financial cost of FLW to the entity;
- identify the "hot spots" where FLW is generated that therefore warrant targeted, prioritized intervention;
- identify which strategies are most appropriate for reducing FLW;
- monitor and evaluate the efficacy of FLW reduction strategies;
- generate statistics on FLW; and/or
- model future trends in FLW.

Although quantification of FLW is a valuable input to strategies for reducing FLW, quantification does not have to precede taking action. Action need not be put on hold until quantification is completed. For instance, quantification and reduction efforts could be undertaken in parallel, with the results of quantification helping to shape and refine future reduction efforts.

Box 3.1 | United Nations Sustainable Development Goals

In September 2015, the United Nations formally adopted a set of 17 Sustainable Development Goals (SDGs) as part of the Post-2015 Development Agenda. SDGs are global goals to end poverty, protect the planet, and ensure prosperity for all. SDG 12 seeks to "ensure sustainable consumption and production patterns." The third target under this goal (Target 12.3) calls for cutting in half per capita global food waste at the retail and consumer level, and reducing food losses along production and supply chains (including post-harvest losses) by 2030.

For more information, see http://www.un.org/sustainabledevelopment/sustainable-development-goals/

3.2 The Implications of Choosing Different Goals

The choice of goals for FLW reduction and quantification will influence the scope of an FLW inventory. For example, an entity's reasons for quantifying FLW will determine the choice of material type (both food and associated inedible parts, only food, or only associated inedible parts). An entity with a goal of reducing the amount of food that exits the supply chain for the sake of enhancing food security will want its inventory to focus on food alone, whereas an entity with a goal of reducing organic material going to landfills for environmental or economic reasons will want its inventory to cover both food and associated inedible parts. An entity may also consider the existing legal definitions in the jurisdiction in which it operates. For example, in the current regulatory framework, the European Commission understands "food waste" to include both food and its inedible parts as material types.[15]

Goals also affect the degree of accuracy required when quantifying FLW. An entity seeking to quantify and report base years and progress over time will need a higher degree of accuracy than one seeking only to gain a general understanding of how much FLW is generated. Section 6.8 provides examples of the implications of various FLW quantification goals for FLW inventory design.

4. Summary of Steps and Requirements

This chapter provides a summary of the steps involved in FLW accounting and reporting, as well as a list of the requirements that must be followed for an FLW inventory to be in conformance with the *FLW Standard*.

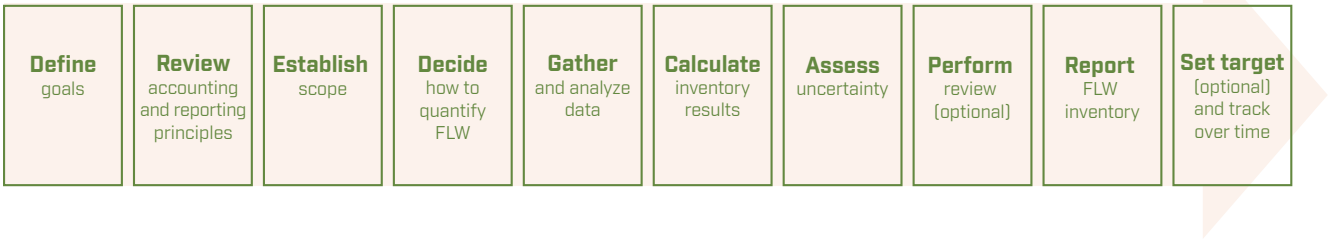
4.1 Accounting and Reporting Steps

The standard is organized according to the steps an entity should follow when developing and reporting an FLW inventory (Figure 4.1). Guidance on each step is provided in subsequent chapters.

The *FLW Standard* guides entities through each step of developing an FLW inventory, with one or more chapters dedicated to each step. The steps are to:

1. **Define goals.** An entity should determine why it is quantifying FLW in order to determine what to quantify and how to undertake the quantification. Goals may relate to food security, economic performance, environmental impact, or some combination of the three.
2. **Review accounting and reporting principles.** An entity quantifying and reporting FLW should adhere to five basic principles for accounting and reporting: relevance, completeness, consistency, transparency, and accuracy. These principles are intended to guide implementation of the standard, especially in situations that are not directly covered by the standard.
3. **Establish scope.** This step involves determining the timeframe, material type(s), destination(s), and boundary that will be covered by the FLW inventory.
4. **Decide how to quantify FLW.** An entity decides whether to undertake a new calculation and/or use existing data, and chooses the quantification method(s) to use in developing the FLW inventory. The method(s) chosen will be influenced by an entity's particular goals, established scope, and other circumstances such as resource availability (e.g., human, financial) and whether it has direct access to the physical FLW.
5. **Gather and analyze data.** An entity begins assembling the data necessary for FLW quantification. The standard provides detailed guidance on a number of approaches for gathering, calculating, and analyzing data related to FLW. The standard also covers approaches for recording the causes of FLW, an option that is recommended for identifying effective FLW reduction strategies.

Figure 4.1 | Overview of Steps in FLW Accounting and Reporting



6. **Calculate inventory results.** Once data have been gathered and analyzed, inventory results can be calculated. The standard provides guidance on performing the necessary calculations. Entities may express FLW in terms or units of measurement in addition to weight (to convey environmental impacts, nutritional content, or financial implications), or use a normalization factor to generate a metric such as FLW per capita. The standard provides guidance in Appendix D.

7. **Assess uncertainty.** In this step, an entity goes through the process of identifying and documenting sources of uncertainty that may arise in the calculation of an FLW inventory. The standard provides suggestions as to how specific forms of uncertainty can be anticipated and minimized.

8. **Perform review.** In this optional step, an entity undertakes either an internal or external assurance process to ensure the accuracy and consistency of the FLW inventory.

9. **Report FLW inventory.** Having completed the prior steps, an entity should report its FLW. The standard provides guidance on reporting the required information as well as the recommended elements that may be added to the inventory report.

10. **Set target and track over time.** An entity may wish to set targets for FLW reduction and use the standard to track progress toward those targets over time. The standard provides guidance on setting an FLW reduction target and tracking it, including information on selecting a base year, monitoring performance, and making adjustments to the base year calculation as needed.

4.2 Summary of Requirements

This standard presents accounting and reporting requirements to help entities prepare an FLW inventory that represents a true and fair account of their FLW. True and fair means that the statements presented are free from known material misstatements and faithfully represent the performance of the entity.

Table 4.1 lists all the requirements that must be followed by an entity when accounting for and reporting on FLW in conformance with the *FLW Standard*. Each requirement is further explained in the following chapters. Five of the requirements (1, 2, 3, 4, and 6) apply to all entities regardless of their situation. Three of them however (5, 7, and 8) are conditional, meaning that they only apply in certain situations (if an entity samples and scales up data; undertakes assurance or review of the FLW inventory; and/or tracks the amount of FLW or sets an FLW reduction target). When they do apply, an entity shall follow the details of those requirements.

In the case of requirements where a user is directed to "describe" information, users of the *FLW Standard* should convey sufficient detail to meet the needs of the intended user of the FLW inventory.

Table 4.1 | Accounting and Reporting Requirements in the *FLW Standard*

REQUIREMENT	CHAPTER IN *FLW STANDARD*
1. Base FLW accounting and reporting on the principles of relevance, completeness, consistency, transparency, and accuracy	Chapter 5
2. Account for and report the physical amount of FLW expressed as weight (e.g., pounds, kilograms, tons, metric tons)	Chapter 7
3. Define and report on the scope of the FLW inventory ***a. Timeframe.*** Report the timeframe for which the inventory results are being reported (including starting and ending date) ***b. Material type.*** Account for and report the material type(s) included in the FLW inventory (i.e., food only, inedible parts only, or food and associated inedible parts) If food or associated inedible parts removed from the food supply chain are accounted for separately in the inventory: ▸ Describe the sources or frameworks used to categorize a material as food or as inedible parts. This includes stating any assumptions that were used to define whether or not material was "intended" for human consumption ▸ Describe the approach used to calculate the separate amounts. If applicable, describe all conversion factors used and their sources ***c. Destination.*** Account for and report the destinations included in the FLW inventory (i.e., where material removed from the food supply chain is directed). If the destination is unknown, then report the initial path(s) at a minimum ***d. Boundary.*** Report the boundary of the FLW inventory in terms of the food category, lifecycle stage, geography, and organization (including the sources used to classify them) ***e. Related issues.*** *Packaging and other non-FLW material.* Exclude from the FLW inventory any material (and its weight) that is not food or associated inedible parts removed from the food supply chain (i.e., FLW). If a calculation is needed to separate the weight of FLW from non-FLW materials (e.g., subtracting the weight of packaging), describe the approach and calculation used *Water added/removed from FLW.* Account for and report the weight of FLW that reflects the state in which it was generated before water was added, or before the intrinsic water weight of FLW was reduced. If a calculation is made to estimate the original weight of FLW, describe the approach and calculation used *Pre-harvest losses.* Exclude pre-harvest losses from the scope of the FLW inventory. Users may quantify such losses but shall keep data separate from the FLW inventory results	Chapter 6
4. Describe the quantification method(s) used. If existing studies or data are used, identify the source and scope	Chapter 7
5. If sampling and scaling of data are undertaken, describe the approach and calculation used, as well as the period of time over which sample data are collected (including starting and ending dates)	Chapter 8
6. Provide a qualitative description and/or quantitative assessment of the uncertainty around FLW inventory results	Chapter 9
7. If assurance of the FLW inventory is undertaken (which may include peer review, verification, validation, quality assurance, quality control, and audit), create an assurance statement	Chapter 12
8. If tracking the amount of FLW and/or setting an FLW reduction target, select a base year, identify the scope of the target, and recalculate the base year FLW inventory when necessary	Chapter 14

5. Principles of FLW Accounting and Reporting

REQUIREMENT

Base FLW accounting and reporting on the principles of relevance, completeness, consistency, transparency, and accuracy

As with financial accounting and reporting, generally accepted principles are intended to underpin and guide accounting and reporting of FLW. Their faithful application helps to ensure that an FLW inventory constitutes a true and fair representation of the FLW selected for quantification. The primary function of the five principles—relevance, completeness, consistency, transparency, and accuracy—is to guide users in the implementation of the *FLW Standard*, and the review or assurance of an FLW inventory. The principles will be of particular value when application of the standard in specific situations is ambiguous or when making accounting and reporting choices not specified by the standard.

The primary function of the five principles—relevance, completeness, consistency, transparency, and accuracy—is to guide users in the implementation of the FLW Standard.

5.1 Explanation of the Principles and Guidance on Their Application

An FLW inventory **shall** be based on the five principles of relevance, completeness, consistency, transparency, and accuracy, which are described in Table 5.1 and in the rest of this chapter.

TRADEOFFS AMONG PRINCIPLES

In practice, an entity may encounter tradeoffs among principles when completing an FLW inventory. For example, it may find that achieving the most complete FLW inventory requires using less accurate data, compromising overall accuracy. Conversely, achieving the most accurate FLW inventory may require excluding components with low accuracy, compromising overall completeness. An entity should balance tradeoffs among principles depending on its individual quantification and reporting goals. For example, tracking performance toward a specific FLW reduction target may require more accurate data. Over time, as the accuracy and completeness of FLW data increase, the tradeoffs among these accounting principles will likely diminish.

Table 5.1 | Principles of FLW Accounting and Reporting: Definitions and Guidance

PRINCIPLE	DEFINITION	GUIDANCE
Relevance	Ensure that the quantification method(s) for developing the FLW inventory and report serve the decision-making needs of the intended user. Present information in the inventory report in a way that is readily understandable by the intended user	A relevant FLW inventory report contains the information that is necessary for an entity's internal and external stakeholders to make their decisions. An entity should use the principle of relevance when determining whether to exclude any components from its inventory scope. It should also use the principle of relevance as a guide when selecting methods for quantification and data sources. An entity should collect data of sufficient quality to ensure that the inventory is relevant (i.e., that it appropriately reflects the FLW being quantified and serves the decision-making needs of users). Selection of methods and data sources depends on an entity's individual goals for quantification. More information on relevance and data collection is provided in Chapters 7 and 8
Completeness	Ensure that the FLW inventory report covers all FLW within the scope selected for the inventory. Disclose and justify any exclusions, for example, FLW that could not be quantified because data were too difficult to collect	An entity should not exclude any components from the FLW inventory that would compromise the relevance of the reported inventory. In some situations, however, an entity may be unable to estimate certain relevant components of FLW due to a lack of data or other limiting factors. In cases where relevant items are not included in an inventory, these exclusions shall be disclosed and justified. Related guidance is included in Section 5.2. As appropriate, assurance providers can determine the potential impact and relevance of the exclusion on the overall inventory report
Consistency	Use consistent methods to allow for meaningful tracking of FLW over time. Provide transparent documentation of any changes to the data, inventory scope, approaches to quantification, or any other relevant factors in the time series	Users of FLW information typically track the information over time in order to identify trends and assess the performance of the reporting entity. The consistent application of inventory scope, approaches to quantification, and assumptions is essential to producing comparable FLW data over time. If there are changes to an inventory scope (e.g., inclusion of previously excluded material types or destinations, changes in the organizational unit due to company divestment or acquisition), quantification methods, data, or other factors affecting FLW amounts, they need to be transparently documented and justified, and may warrant recalculation of the base year FLW inventory. More information on consistency when tracking performance over time is provided in Chapter 14
Transparency	Address all relevant issues in a factual and coherent manner, based on clear documentation. Disclose any relevant assumptions and make appropriate references to the quantification methods and data sources used in the inventory report. Clearly explain any estimates and bias so that the FLW inventory report represents what it purports to represent as well as possible	Transparency relates to the degree to which information on the processes, procedures, assumptions, and limitations of the FLW inventory are clearly documented, and disclosed in a factual, neutral, and understandable manner. Information should be recorded, compiled, and analyzed in a way that enables internal reviewers and external assurance providers (as appropriate) to attest to its credibility. Specific exclusions need to be clearly identified and justified, assumptions disclosed, and appropriate references provided for the approaches applied and the data sources used. The information should be sufficient to enable a party external to the inventory process to derive the same results if provided with the same source data. A transparent inventory report provides a clear understanding of the relevant issues and a meaningful assessment of the FLW quantified. More information on reporting is provided in Chapter 13

Table 5.1 | Principles of FLW Accounting and Reporting: Definitions and Guidance (continued)

PRINCIPLE	DEFINITION	GUIDANCE
Accuracy	Ensure that the quantification of FLW is systematically neither more nor less than actual FLW, as far as can be judged, and that uncertainties are reduced as far as practical. Achieve sufficient accuracy to enable the intended user to make decisions with reasonable confidence as to the integrity of the reported information	Data should be sufficiently accurate to enable intended users to make decisions with reasonable confidence that the information in the inventory is credible. It is important that the amounts quantified be as accurate as possible to guide the decision-making needs of the user and ensure that the FLW inventory is relevant. If the data are not sufficiently precise to meet its business goals, an entity should start identifying what needs to change to obtain more useful data. An entity should reduce uncertainties in the quantification process as far as is relevant and practical. Reporting on measures taken to ensure improvements in accuracy over time can help promote credibility and enhance transparency. More information on accuracy when collecting data is provided in Chapters 7 and 8, and in the *Guidance on FLW Quantification Methods*

5.2 Guidance: Disclosing and Justifying Exclusions

Users of the *FLW Standard* should strive for completeness, but accounting for all FLW within the scope of an inventory may not always be feasible. Excluding some FLW may be necessary in certain cases due to limitations such as measurability or data availability, or user resources and capacity. With this in mind, users may exclude FLW from an inventory, but **shall** disclose and justify such exclusions.

When deciding whether to exclude the amount of any FLW, users of the standard **shall** follow the principles of relevance, completeness, accuracy, consistency, and transparency and therefore shall not exclude any FLW that would adversely affect the decision-making needs of the intended user.

Instead of excluding FLW, where possible an entity may use:

- simplified or less rigorous estimation methods to approximate the amount of FLW; or
- proxy data to fill data gaps.

In these cases, in line with the requirement to disclose quantification methods and sources of uncertainty, users shall be transparent in the inventory about the limitations of any calculation approaches used.

PART II
MAIN REQUIREMENTS

The chapters in Part II set out the requirements and guidance related to two of the requirements in this standard: to define and report on the scope of an FLW inventory (Chapter 6), and to describe the quantification method used (Chapter 7).

6. Establishing the Scope of an FLW Inventory

REQUIREMENT: DEFINE AND REPORT ON THE SCOPE OF THE FLW INVENTORY	
Timeframe (Section 6.3)	Report the timeframe for which the inventory results are being reported (including starting and ending date)
Material Type (Section 6.4)	Account for and report the material type(s) included in the FLW inventory (i.e., food only, inedible parts only, or food and associated inedible parts) If food or associated inedible parts removed from the food supply chain are accounted for separately in the inventory: a. Describe the sources or frameworks used to categorize a material as food or as inedible parts. This includes stating any assumptions that were used to define whether or not material was "intended" for human consumption b. Describe the approach used to calculate the separate amounts. If applicable, describe all conversion factors used and their sources
Destination (Section 6.5)	Account for and report the destinations included in the FLW inventory (i.e., where material removed from the food supply chain is directed). If the destination is unknown, then report the initial path(s) at a minimum
Boundary (Section 6.6)	Report the boundary of the FLW inventory in terms of the food category, lifecycle stage, geography, and organization (including the sources used to classify them)
Related Issues (Section 6.7)	▶ *Packaging and other non-FLW material.* Exclude from the FLW inventory any material (and its weight) that is not food or associated inedible parts removed from the food supply chain (i.e., FLW). If a calculation is needed to separate the weight of FLW from non-FLW materials (e.g., subtracting the weight of packaging), describe the approach and calculation used ▶ *Water added/removed from FLW.* Account for and report the weight of FLW that reflects the state in which it was generated before water was added, or before the intrinsic water weight of FLW was reduced. If a calculation is made to estimate the original weight of FLW, describe the approach and calculation used ▶ *Pre-harvest losses.* Exclude pre-harvest losses from the scope of the FLW inventory. Users may quantify such losses but shall keep data separate from the FLW inventory results

6.1 Guide to Chapter 6

This chapter is concerned with establishing the scope of an FLW inventory, which is about "what to quantify." "What" an entity quantifies will be influenced by its goals and will define its choices for "how" to quantify FLW, which is addressed in Chapters 7 and 8.

A well-defined scope, aligned with the five accounting principles and an entity's goals, is important to ensure that an FLW inventory meets an entity's needs.

Establishing the scope of an FLW inventory involves selecting the timeframe, material type, destinations, and boundary of the inventory. This chapter describes the specific accounting and reporting requirements associated with each of these four components (see table above), and provides guidance for implementing them.

6.2 Defining the Scope of an FLW Inventory

In order to be in conformance with the *FLW Standard*, users **shall** define and report on the scope of their FLW inventory. The scope is defined by four components (see Figure 6.1):

- **Timeframe**: the period of time for which the inventory results are being reported
- **Material type**: the materials that are included in the inventory (food only, inedible parts only, or both)
- **Destination**: where FLW goes when removed from the food supply chain
- **Boundary**: the food category,[16] lifecycle stage, geography, and organization

An entity should define a scope that aligns with the goal or goals that underlie its decision to quantify FLW. In some cases, the scope will be clearly established by an external party—such as an industry association, government, or intergovernmental body—that has an FLW reduction and/or reporting target, program, and/or policy. These external party efforts may be prescriptive and dictate the components of the scope that must be included in an inventory. This approach can reduce transaction costs, facilitate comparisons between entities, or meet other objectives. In other cases, the scope may be defined by the entity itself for internal priority setting or benchmarking purposes. In these cases, an entity has more freedom to customize the scope to meet its internal goals.

The *FLW Standard* provides users with definitions for the material types and destinations, as well as internationally accepted classifications for delineating the four dimensions associated with setting an FLW inventory's boundary. Consistent use of these definitions and classifications will provide transparency and consistency across FLW inventories and will facilitate comparisons among inventories.

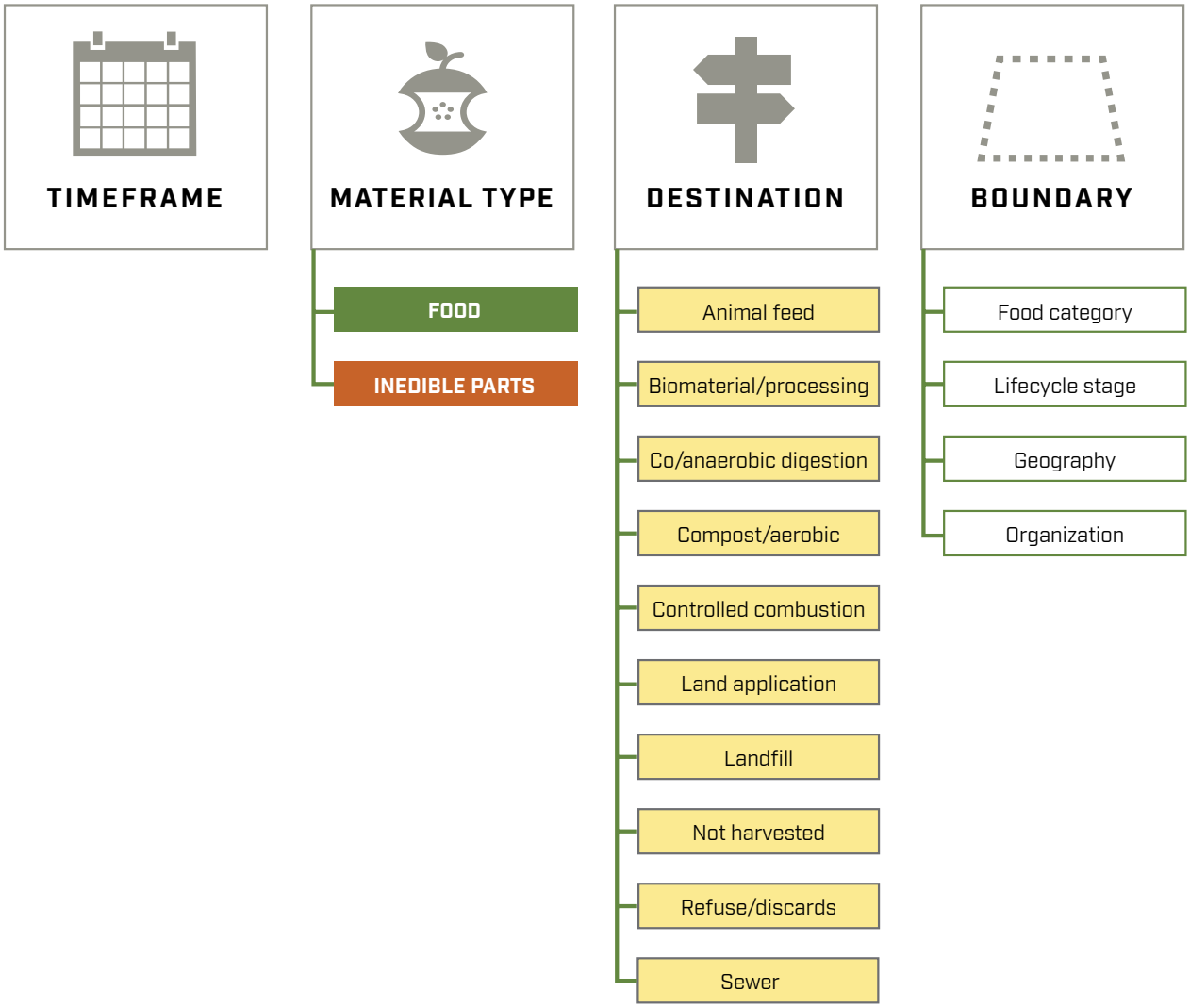
6.3 Timeframe

Users of the *FLW Standard* **shall** define and report the timeframe for which the inventory results are being reported (including starting and ending date).

Users should report inventory results over the course of a 12-month period to account for any seasonal variations and facilitate the comparison of FLW inventories. This is highly recommended; however, it is not required because there are some situations in which a 12-month reporting period is not relevant. For example, an entity may measure FLW for only a week or month, take action, then reassess the amount of FLW. Where seasonality is not a large issue, this approach is unlikely to have a negative impact on quantification results; in this case, data may even be more accurate if an entity simply reports the time period covered instead of extrapolating for 12 months. In other cases, an entity may quantify FLW only for a particular occasion (e.g., a festival, sporting event, or for one or more harvest seasons), in which case reporting over a 12-month period would not be appropriate.

The standard does not specify how frequently an entity should quantify FLW. How often an entity quantifies FLW (e.g., every other year, every five years) should be based on its specific goals, its available resources, external requirements, and the time it is expected to take before quantities of FLW begin to change. Section 14.4 provides guidance on selecting the frequency of quantifying FLW.

Figure 6.1 | Scope of an FLW Inventory



An entity should define a scope that aligns with the goal or goals that underlie its decision to quantify FLW.

6.4 Material Type

Users of the *FLW Standard* **shall** account for and report the material type included in their FLW inventory. "Material type" refers to whether the material that was removed from the food supply chain and quantified in an FLW inventory is food, associated inedible parts, or both (See definitions in Box 2.1). Depending on an entity's goals, the material type included in the inventory may be:

- Both food and associated inedible parts
- Food only, or
- Associated inedible parts only

The *FLW Standard* allows users to account for and report on the two material types together (i.e. as a combination of food and associated inedible parts), or separately. Therefore, there are four possible ways for users to report their inventory results for material that has been removed from the food supply chain:

1. The material types combined (i.e., not separated).
2. The material types combined and also disaggregated into separate results for each type.
3. Only food.
4. Only associated inedible parts.

For options 2, 3, and 4, there are two additional reporting requirements because a distinction is being made between the types of material removed from the food supply chain. Users **shall**:

- Describe the sources or frameworks that were used to categorize a material as food or as associated inedible parts. This includes stating any assumptions that were used to define whether or not a material was intended for human consumption.
- If estimates were made to quantify separately the food or associated inedible parts removed from the food supply chain, describe the approach used and, if applicable, all conversion factors and their sources. Section 8.2 provides guidance on this requirement.

POSSIBLE BENEFITS OF QUANTIFYING MATERIAL TYPES SEPARATELY

It can be valuable to distinguish material that is considered food—and intended for human consumption based on the particular food supply chain, customs, and standards of the society in question—from that which is not. Knowing the separate quantities of food and associated inedible parts can help entities appreciate the size of the opportunity to improve food security (and achieve other benefits) by preventing food from leaving the food supply chain.

For example, it was known that a large amount of "kitchen waste" was being generated by households in the United Kingdom (UK). However, because the relative proportions of food and associated inedible parts in this waste stream were not known, the uncertainty contributed to inaction—there was no evidence to counter suggestions that the waste stream comprised all inedible parts. It was not until 2007, when *The Food We Waste*[17] study showed that the vast majority was food, that campaigning and public engagement to prevent household food waste in the UK greatly accelerated.

Conversely, understanding the amount of FLW that is considered inedible parts can present an opportunity to increase the availability of food. Entities are exploring different technologies, additional processing, or changing cultural norms in order to transform materials considered inedible today into a food source in the future. Even if substances are categorized as associated inedible parts in an FLW inventory, an entity should consider whether these substances could be captured for human consumption, and consider incorporating this conversion into its FLW reduction strategy.

GUIDANCE: CATEGORIZING MATERIAL TYPES AS FOOD OR ASSOCIATED INEDIBLE PARTS

This section provides guidance for users of the *FLW Standard* that report inventory results separately for food or associated inedible parts. The standard requires that users describe the sources or frameworks used to categorize these material types.

Categorizing a material as food requires stating what assumptions underlie the decision to view it as "intended for human consumption." Conversely, categorizing a material as inedible parts requires stating the assumptions that underlie the decision to view it as "not intended for human consumption."

What is considered "intended" for human consumption varies among food supply chains. For example, a food processing company that does not use the skin of potatoes in its products may categorize and report the skin as "not intended" for human consumption and therefore as an associated inedible part in its food supply chain. Another company might use potato skin as part of the final product, and the skin would be categorized and reported as food because it is "intended" for human consumption. In both these cases, if the entity reports its FLW inventory results separated by material type, it is required to state the basis on which it categorized potato skins as "food" or "inedible parts."

A rule of thumb for determining whether a product is "intended" for human consumption relates to whether the product is sold within the food supply chain. For example, if an entity sells potato skins as part of its processed food product or, sells fish bones as an ingredient for making broth, then the entity should consider the skins, or fish bones, to be "food."

Cultural factors are equally important determinants in categorizing material as food or associated inedible parts. For example, although cattle hooves are consumed in Africa, they are not eaten in Europe. Cattle hides may be thrown away or sent to a tannery in southern Africa but they may be eaten in West Africa. In the UK, chicken feet will in most cases be considered associated inedible parts but chicken feet are commonly eaten in China, where they would be categorized as food. Indeed, British chicken feet are commonly sold to the Chinese market for human consumption, illustrating that the separate quantification of food and associated inedible parts may be worthwhile both economically and from a global food security perspective.

Despite these inherent ambiguities, consistent definitions of "intended" for consumption and "inedible" should be used where possible. Rather than individual users developing their own definitions for designating material as a food or not, it would be better for definitions to align with a small number of relevant frameworks. This is likely to increase the comparability of FLW inventories. Section 8.2 provides additional guidance about this issue and Appendix B provides sources that could be useful for defining "inedible parts."

GUIDANCE: WHEN THE ULTIMATE PURPOSE OF MATERIAL IS NOT KNOWN, OR CHANGES

In some cases, it may not be known from the outset whether or not a substance is destined to become food. For example, a farmer producing a crop may not know at the time of harvest whether it will be used for biofuel, bioplastic, or food. In these circumstances, an entity may quantify FLW using general statistical information on the fraction of the material in question that, in a specific region and year, enters a human food market (in this example, the proportion of the crop that is consumed as food in a given year and region). While the *FLW Standard* may be relevant to agricultural raw materials grown or used for purposes other than food, it has been neither developed nor tested with these purposes in mind.

As a substance proceeds along the food supply chain, its intended use may also change based on various factors including relative profit margins. The *FLW Standard* is intended for use in those parts of the supply chain where a substance is handled as food.

6.5 Destination

Users of the *FLW Standard* **shall** account for and report as much as is known about the destination of the FLW. "Destination" refers to where material removed from the food supply chain is directed. If the destination is unknown, users **shall,** at a minimum, report the initial path(s). The "path" refers to the route by which FLW moves to its destination.

There is a range of possible destinations for food and/or associated inedible parts removed from the food supply chain. These destinations differ significantly. Some result in no valorization[18] of the FLW (i.e., they represent final disposal) while others result in outputs with value. Table 6.1 lists the 10 destinations used by the *FLW Standard* in alphabetical order, along with their definitions.

These 10 categories represent the most likely destinations to which food and/or associated inedible parts will be

Table 6.1 | Definitions of the 10 FLW Destinations

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

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

directed when they are removed from the food supply chain. In the rare case that FLW goes to a destination not currently listed, users of the standard are required to use the "other" category and describe the destination.

The destinations in Table 6.1 are focused on the *processes* used to convert FLW, rather than on the ultimate *output* (e.g., fuel, soil amendment) because, in many cases, an entity will not know the ultimate output of its FLW. Even if the ultimate output is known, it can be difficult for an entity to allocate the weight of its FLW among the ultimate outputs. This is because a process (e.g., anaerobic digestion) may transform FLW into multiple materials (e.g., a biogas, a liquid, and a solid residual), each of which in turn may be converted into further outputs (e.g., fuel, fertilizer, soil amendment).

The destinations in Table 6.1 provide entities with a universally consistent way to define, understand, organize, and report on the diversity of destinations for food and/or associated inedible parts removed from the food supply chain. Just as the selection of "food" and/or "inedible parts" will vary among entities, so will the combination of destinations that are considered "loss and waste" for any particular entity. The destinations that are to be considered "loss and waste" are defined by the entity's goal, local legislation, external policy, voluntary program, or another source separate from the FLW Protocol. For example, the recommendation of FUSIONS to the European Commission is that "food waste" should refer to food and associated inedible parts sent to all destinations except animal feed and bio-based materials/biochemical processing.[19] The Consumer Goods Forum's Food Waste Resolution of 2015, in contrast, defines "food waste" as food and/or associated inedible parts sent to landfills, controlled combustion [without energy recovery], or sewers.[20]

When comparing one FLW inventory to another (within or between entities), it is important to know which destinations are included in each inventory's scope. An FLW inventory that includes only a few destinations differs significantly in scope from an inventory that includes all 10 destinations.

GUIDANCE: ACCOUNTING FOR AND REPORTING ON DESTINATIONS

Entities vary greatly in their knowledge about the destination of their FLW. The *FLW Standard* therefore requires users to account for and report as much as they currently know about the destination(s) of their FLW.

If the destination is unknown, users of the *FLW Standard* are required, at a minimum, to report the initial path(s)—how FLW gets to the destination. Over time, more data on FLW by destination will become available as the benefits of quantifying FLW are broadly recognized, knowledge is expanded about opportunities to extract value from FLW, and actions are taken to meet targets for reducing FLW.

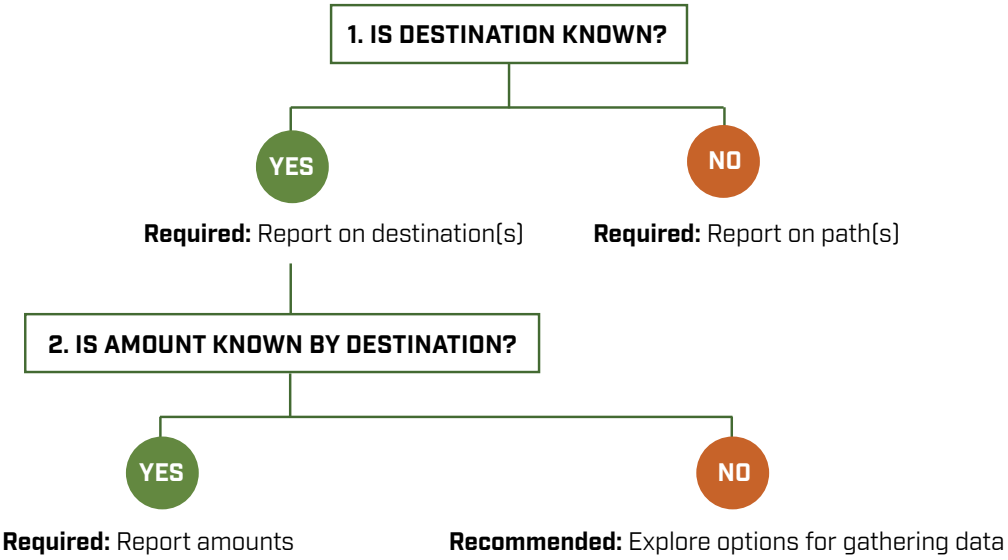
The standard delineates three types of paths:

1. **On-site removal or use of FLW.** Examples include any situation in which the FLW is used at the place where it was generated.
2. **Other entity collects/hauls FLW off site.** Examples include a waste management company or others taking FLW from where it was generated.
3. **Other paths, typically informal.** Examples include food abandoned on the side of the road, or food and associated inedible parts remaining in a public space after a festival.

If the destination is known, users are required to indicate which of the 10 destinations are included in their inventory. (An entity may also report the path though is not required to do so.) If users can account for the amount of FLW that went to a particular destination, they are required to report the weight of FLW by destination.

The *FLW Standard* requires users to account for and report as much as they currently know about the destination(s) of their FLW (see Figure 6.2).

Figure 6.2 | Summary of Requirements Based on What is Known about Paths and Destinations



If an entity uses an on-site system as an intermediate step for processing FLW (e.g., by macerating, dehydrating, or liquefying the FLW), it is required to report the path/destination (if known) of the FLW ***after*** this "pre-processing" step has been completed. The amount of FLW reported, however, should be based on the weight of FLW ***before*** any pre-processing occurred (see Section 6.7 for related guidance and Box 6.1 for an illustrative example).

GUIDANCE: VALORIZATION OF FLW

Where the destination is known, the standard strongly recommends that, to enhance the comparability and transparency of an inventory, an entity understand the extent to which FLW is valorized by the facility that receives its FLW.

For five of the destinations (codigestion/anaerobic digestion, composting/aerobic processes, controlled combustion, landfill, and sewer/wastewater treatment), the types of facilities accepting the FLW can differ greatly, which influences the degree to which FLW is valorized. For example, some controlled combustion facilities or wastewater treatment facilities are designed to recover energy, while others dispose of the FLW with no valorization. (For the other five destinations—animal feed, bio-based materials/biochemical processing, land application, not harvested/plowed-in, refuse/discards/litter—FLW is generally valorized or not.)

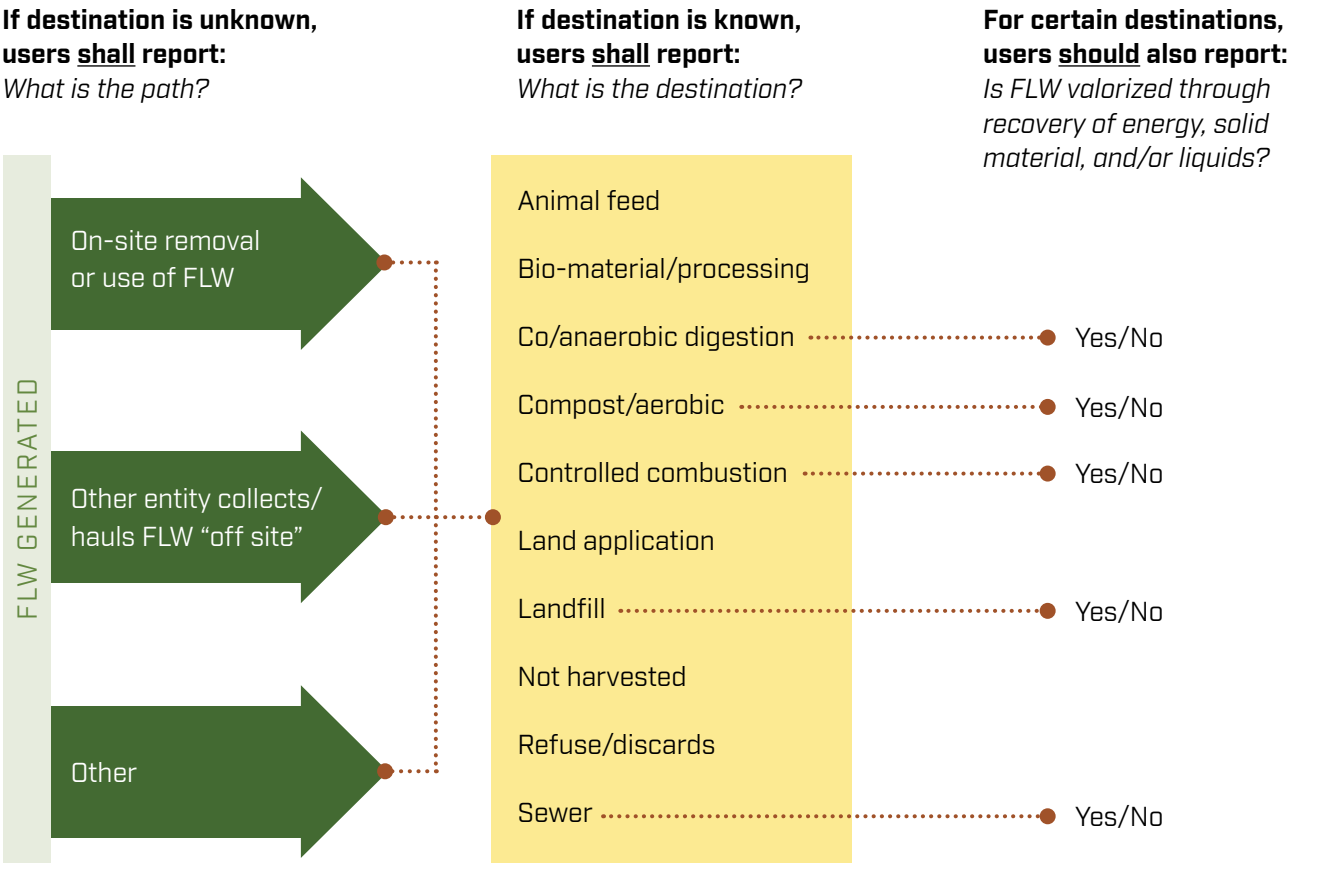
Given that, for the first five destinations listed above, the extent to which FLW is valorized—and which resources (i.e., energy, solid materials, liquids) are recovered—differs, an entity should include relevant information in its FLW inventory report, if available. This should include whether the FLW is valorized, the proportion of FLW valorized, and what resources are recovered. If an entity does not know what happens to the FLW once delivered to the destination, it should ask whether FLW is valorized and what resources are recovered.

Moreover, in the case of two of these five destinations in particular (codigestion/anaerobic digestion and composting/aerobic processes), the FLW is typically valorized, but it is important to keep in mind that there are differing degrees to which resources are recovered for further use. For example:

- Codigestion/anaerobic digestion produces a biogas as well as a solid material and liquid residual. Typically the biogas is recovered for energy. In some cases the solid and/or liquid material may be recovered as well and processed further into other outputs (e.g., to produce a soil amendment). In other cases, these residual materials may not be valorized further and simply sent to other destinations, such as a landfill.
- Composting through aerobic processes produces an organic solid material that is known for being converted into a useable output, such as a soil amendment. However, it also produces a liquid that may or may not be recovered and converted into a useable product.

Figure 6.3 provides a summary of what users shall and should report in terms of the paths and destinations of FLW as well as valorization. (A spreadsheet-based reporting template is available at www.flwprotocol.org to help users report this information.)

Figure 6.3 | Paths, Destinations, and Valorization of FLW



The standard defines the terms "energy recovered," "solid material recovered," and "liquid recovered" as follows:

- **Energy recovered:** Conversion into useable heat, electricity, or fuel
- **Solid material recovered:** Conversion of digested solids or other material outputs into useable products, such as fertilizer (which provides plant nutrients), bedding for livestock, or soil amendments (which improve the physical condition of soil)
- **Liquid recovered:** Conversion of liquid into a useable product, such as fertilizer.

Additional information about steps taken to ensure that liquid or solid materials recovered meet quality standards may also be reported (e.g., if composted material meets a third-party standard such as that developed by the American Society for Testing and Materials [ASTM]).

Box 6.1 illustrates how an entity may report FLW that goes to different paths and destinations.

Considerations: Linking Destinations to an "FLW Management Hierarchy"

Many organizations involved in efforts to address FLW have developed "management hierarchies" that rank—as more or less preferable—various strategies for managing FLW. They are often referred to as "waste management," "food recovery," or "food use" hierarchies, and are usually presented diagrammatically in the form of an inverted pyramid. The bottom (tip) of the pyramid represents the least preferred destinations, which are often referred to as "disposal." The *FLW Standard* does not recommend one particular FLW management hierarchy over another. Instead it includes a comprehensive set of destinations that are represented across a number of hierarchies.[21] This allows the standard to be relevant across all nations and sectors.

The FLW Protocol supports the universal recommendation to prioritize prevention of FLW, which includes source reduction (i.e., reducing the generation of surplus food) and rescuing surplus wholesome food for human consumption. However, because the *FLW Standard* is focused on material no longer in the food supply chain; the rescue of food and redistribution to people through food banks and other charities is outside the scope of the standard. Nonetheless, given the importance of diverting surplus wholesome food to people in need, Appendix E of the standard provides an introductory overview on quantifying and reporting the weight of food rescued to feed people.

When FLW is produced, the first best use is generally considered to be feeding animals, followed by using FLW for "bio-based materials and biochemical processing." Thereafter, perspectives tend to differ about what is the next "preferred option" or a "more beneficial use." The options for diverting FLW are influenced by a number of factors, including local legislation, available infrastructure, and technologies for managing FLW. In general, entities with experience in quantifying FLW have found that, where FLW is collected separately from other material, the likelihood of it being directed to a "more beneficial use" is often greater (as is the accuracy of the quantification).

Box 6.1 | Hypothetical Example of Reporting Multiple Paths, Destinations, and Amounts of FLW

This hypothetical example is of a restaurant reporting on three sources of FLW. The figure in this box summarizes the paths, destinations, and hypothetical amount of FLW reported for the FLW generated in this example.

1. **Used cooking oil** is a common source of FLW in restaurants, and is often collected by a third party. There are well-established markets for recycling used oil that would fall under the destination called "bio-based materials and biochemical processing." The oil may be converted into a wide array of products. The choice of final outputs is made by the facility processing the oil.

For this source of FLW, the restaurant would report the "destination" as "bio-based materials and biochemical processing." (If it so desired, it could report the path of "other entity collects/hauls FLW off site" for this source of FLW—and the other paths in this example—but because the destination is known, reporting the path is not required). The restaurant operator typically segregates the oil from other materials and will therefore be able to report the weight (though will likely need to convert it to a weight from the volume).

2. **"Preparation" FLW** (which together with used cooking oil may also be referred to as kitchen, back-of-the-house, or pre-consumer FLW) is usually composed of multiple ingredients. The restaurant may use a dehydrator to reduce the weight and volume of FLW during storage. In this case, it would report the weight of the FLW *before* it is dehydrated. It would report on the "destination" based on where FLW is directed *after* processing in the dehydrator.

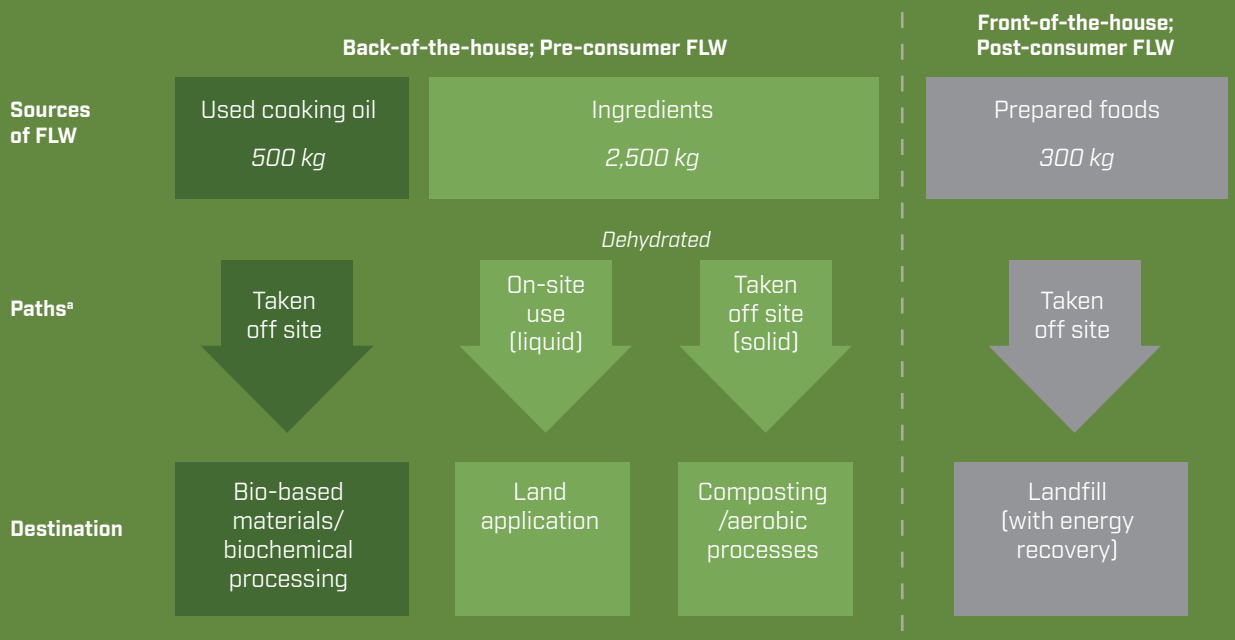
After the FLW is dehydrated, liquid and solid materials are created, which may not go to the same destination. In this example, the liquid condensate generated by the dehydrator may be collected and used to water the on-site landscaping. In this case, the path is "on site" and the restaurant would report the "destination" as "land application." If the solid residual that is generated is collected by a third party and taken "off site" for composting, the restaurant would report the "destination" as "composting/aerobic processes." The restaurant is required to report these destinations and may choose to also report the paths but reporting the paths is not required by the standard. The restaurant may not be able to attribute how much FLW was separated into liquid versus solid material and how much FLW therefore went to the respective destinations.[a]

3. "**Front-of-the-house" FLW** (also referred to as post-consumer FLW) may be composed of food uneaten by customers in addition to disposable serving ware, such as plastic cutlery, cups and napkins. This FLW may be picked up by a waste hauler and taken "off site" to the local landfill. For this source of FLW, the restaurant would report "destination" as "landfill" and, if it knows that methane is recovered at the landfill for energy, should also include this added level of information.

Different quantification methods may be used to calculate the amount of this FLW and, importantly, the weight of non-FLW material (disposable serving ware in this example) will need to be excluded. There may be reference sources available to estimate the weight of the non-FLW material, or a waste composition analysis may be undertaken to determine the proportion of FLW versus non FLW-material, and therefore estimate the weight of the FLW.

[a] A known proportion or conversion factor may be available from the dehydrator manufacturer or other sources that the restaurant could use to estimate the original weight of FLW sent to each destination after dehydration. For instance, one study in the United States found that a typical dehydrator will convert 250 pounds of FLW into 25 pounds of sterile organic biomass and 25 gallons, or 208 pounds, of water. Using these figures, the restaurant could estimate what proportion of the original FLW went to the two destinations noted above (land application, and composting).
Source: Neale (2013).

Box 6.1 | Hypothetical Example of Reporting Multiple Paths, Destinations, and Amounts of FLW (continued)



[a] Reporting paths is not required because the destinations are known but the restaurant may choose to report this information.

Where the destination is known, the standard strongly recommends that, to enhance the comparability and transparency of an inventory, an entity understand the extent to which FLW is valorized by the facility that receives its FLW.

6.6 Boundary

Users of the *FLW Standard* **shall** report the boundary of their FLW inventory and describe it in terms of: food category, lifecycle stage, geography, and organizational unit. Description includes listing the classification source(s) used and relevant codes, where applicable.

Table 6.2a provides definitions for these elements, as well as several examples that may be relevant to an FLW inventory.

The *FLW Standard* strongly recommends using the classification sources listed in Table 6.2b to improve transparency and comparability among FLW inventories. Globally consistent classification standards give entities a common language for categorizing boundaries in the same way around the world. If an entity is not able to use the classification sources listed in Table 6.2b (e.g., because the food category or type of economic activity for its FLW inventory is not listed), it is required to delineate the boundary of its FLW inventory as clearly as possible. When using the classification sources, users should always check to be sure that they are using the latest version of these sources.

Table 6.3 provides three illustrative examples of how the boundary may be reported.

Table 6.2a | Boundary Definitions and Examples

BOUNDARY DIMENSION	DEFINITION	EXAMPLES
Food category	The types of food included in reported FLW[a]	▶ All food ▶ Dairy products ▶ Fresh fruits and vegetables ▶ Chicken
Lifecycle stage	The stages in the food supply chain or food lifecycle within which reported FLW occurs	▶ Entire food supply chain ▶ Two stages: manufacture of dairy products, and retail of food and beverage ▶ At home
Geography	Geographic borders within which reported FLW occurs	▶ World (all countries) ▶ Eastern Asia ▶ Ghana ▶ Nova Scotia, Canada ▶ Lima, Peru
Organization	Organizational unit(s) within which reported FLW occurs	▶ All sectors in country ▶ Entire company ▶ Two business units ▶ All 1,000 stores ▶ 100 households

[a] "Food category" differs from "material type," which refers only to whether FLW is composed of "food" and/or "associated inedible parts" removed from the food supply chain

Table 6.2b | Boundary Classification Sources and Examples with Codes

BOUNDARY DIMENSION	CLASSIFICATION SOURCE TO USE (SELECT THE MOST CURRENT VERSION)	SELECTED EXAMPLES WITH RELEVANT CODES

Food category	▸ Select one or more categories from either the Codex General Standard for Food Additives (GSFA)[a] system or United Nations Central Production Classification (CPC)[b] system
	▸ If more detailed information is used, include appropriate codes from more granular sources including:
	  ▸ Global Product Category (GPC) codes[c] (online, or download an Excel, Word or XML copy)
	  ▸ United Nations Standard Products and Services Code (UNSPSC)[d]
		▸ All food
		(GSFA 01.0–16.0) *or*
		(CPC2.1 Divisions 21–24)
		▸ Dairy products
		(GSFA 01.0) *or*
		(CPC2.1 Group 221 & 222)
		▸ Fresh fruits and vegetables
		(GSFA 04.1 & 04.2.1) *or*
		(CPC2.1 Group 012 & 013)
		▸ Chicken
		(GSFA 08.1.1 {Fresh meat, poultry, and game, whole pieces or cuts}; GPC Brick 10005769)
		or
		(CPC2.1 Subclass 21121)

Lifecycle stage	▸ Select one or more United Nations International Standard Industrial Classifications of All Economic Activities (ISIC) codes[e] (At the time of publication, the latest version is "Rev.4") ▸ Regional and national classification systems may be used as well, most of which are derived from the ISIC (e.g., NACE for Europe). The UN Statistics Division lists national classification systems[f] ▸ If no code exists, write in the lifecycle stage	▸ Entire food supply chain (select relevant group of ISIC codes) ▸ Two stages: manufacture of dairy products (ISIC Group: 105) and retail of food and beverage (ISIC Class: 4721) ▸ At home (ISIC Class: 9820)
Geography	▸ Select one or more UN regions or country codes[g] ▸ Write in description for narrower geographic scope Where available, use a national classification system (e.g., U.S. Census)	▸ World/all countries (UN code 001) ▸ Eastern Asia (UN code 030) ▸ Ghana (UN code 288) ▸ Nova Scotia, Canada ▸ Lima, Peru
Organization	Write in number and type of unit(s) and any additional descriptive detail (see guidance in pages that follow)	▸ All sectors in country ▸ Entire company ▸ Two business units ▸ All 1,000 stores ▸ 100 households

At the time of publication, websites for classification sources are as follows:

[a] GSFA: http://www.fao.org/gsfaonline/foods/index.html?lang=en

[b] CPC: http://unstats.un.org/unsd/cr/registry/cpc-21.asp

[c] GPC: http://www.gs1.org/1/productssolutions/gdsn/gpc/browser/index.html (online); http://www.gs1.org/gpc/gpc-food-beverage-tobacco/archive (Excel, Word or XML)

[d] UNSPSC: http://www.unspsc.org/

[e] ISIC: http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27&Lg=1

[f] National industry classification systems: http://unstats.un.org/unsd/cr/ctryreg/default.asp?Lg=1

[g] UN codes: http://unstats.un.org/unsd/methods/m49/m49regin.htm

Table 6.3 | Illustrative Examples of an Inventory Boundary

SAMPLE RESPONSES	**FOOD CATEGORY** (The types of food included in reported FLW) *Use GSFA or CPC categories. Also note any other codes that provide more detail*	**LIFECYCLE STAGE** (The stages in the food supply chain or food lifecycle within which reported FLW occurs) *Use one or more ISIC codes. National codes may be used. Write in the stage if no code exists*	**GEOGRAPHY** (Geographic borders within which reported FLW occurs) *Use UN codes and detail from national source*	**ORGANIZATION** (Organizational unit(s) within which reported FLW occurs) *Write in number and type of units (and any additional details)*
Processor of instant coffee, reporting on FLW from all direct operations	GSFA category: Category 14.1.5—Coffee, coffee substitutes and other hot drinks *or* CPC2.1 category: Subclass 23911—Coffee, decaffeinated or roasted GPC code: Brick: 10000115—Coffee instant	One stage: 1. Processing ISIC Class: 1079—Manufacture of other food products	Switzerland (UN code 758)	Three coffee factories
Global dairy manufacturer reporting on FLW of milk at one facility, from its own manufacturing operation as well as upstream and downstream	GSFA category: Category 1.1.1.1—Milk (plain) *or* CPC2.1 category: Subclass 22110—Processed liquid milk GPC code: Brick: 10000026—Milk/Milk Substitutes (shelf stable)	Five stages (ISIC codes): 1. Class: 0141—Raising of cattle and buffaloes *and* 2. Class: 1050—Manufacture of dairy products *and* 3. Class: 4912—Freight rail transport *and* 4. Class: 4721—Retail sale of food in specialized stores *and* 5. Class: 9820—Undifferentiated service-producing activities of private households for own use	Pakistan (UN code 586), Sheikhupura	One dairy factory's FLW from milk production through to milk consumption
Town in the United States reporting on FLW for single-family units across all food and drink categories	GSFA category: All (i.e., Categories 01.0–16.0) *or* CPC2.1 category: Divisions 21–24	One stage: 1. Class: 9820—Undifferentiated service-producing activities of private households for own use	USA (UN code 840), Aberdeen, SD (CBSA code 10100)	10,000 single-family homes

GUIDANCE: REPORTING ON "FOOD CATEGORY"

"Food category" differs from "material type." "Food category" refers to the types of food included in the FLW being reported. "Material type" refers to the composition of the FLW, that is, food, associated inedible parts, or both.

A clear description of the food categories in an FLW inventory provides important context for the individuals analyzing inventories and making decisions. For example, the inclusion in an FLW inventory of drinks, other liquids, or semi-solid items (e.g., broth, yogurt, incidental/secondary products from food processing such as whey or oil) may significantly impact the weight of reported FLW because these types of items are heavy. When comparing one FLW inventory to another, an entity should keep in mind how the composition of food categories may impact the weight.

An entity will include different categories of food(s) in an FLW inventory, based on its goals for quantification and ability to separate and identify different components. For example, a coffee manufacturer wishing to improve the efficiency of its coffee processing operations might report only on the category of "instant coffee" (see Table 6.3). In contrast, a municipality reporting on the amount of FLW might want to understand the amount of FLW generated by households and will likely report that it includes "all food and beverage categories."

There is no single classification system for food categories that can be universally applied to prepare an FLW inventory.[22] Users of the *FLW Standard* should, however, at a minimum, report their FLW using one of two systems: *either* the codes provided by the Codex Alimentarius General Standard for Food Additives (GSFA) system *or* the United Nations' Central Product Classification (CPC) system. (At the time of publication, the latest version for GSFA was: "Updated up to the 38th Session of the Codex Alimentarius Commission (2015)," and the latest version for CPC was "Version 2.1.") Both these systems enable the food categories included in an FLW inventory to be reported at a broad level. While the organization of the codes is slightly different, in most instances a code used in one system has a corresponding code in the other.

The GSFA is used by FAO and the World Health Organization; it provides a list of 16 food categories along with a description of the foods in each category. Its primary purpose is to describe allowable food additives for various food categories but, while designed for a use other than FLW, it provides a useful high-level classification of food products.

The CPC is managed by the United Nations Statistics Division and covers products across all types of economic activities, that is, it extends beyond agriculture, fishery, and food products.[23] Although the CPC system is not focused exclusively on the food sector, it allows an entity to report more detail for some categories than does the GSFA system (e.g., it provides more classification options for agricultural items such as fruits, vegetables, and grains).

If an entity reports on a broad category such as "all food and beverage categories" (GSFA codes 01.0–16.0, or CPC2.1 Divisions 21–24) but has made a deliberate decision to exclude specific types of products or any food categories, it is required to disclose this exclusion. For example, a retailer may quantify all the food and beverage categories in its store but, for various reasons, may choose not to include water packaged explicitly for the purpose of drinking (GSFA code 14.1.1, or CPC2.1 Class 2441).

If the GSFA or CPC codes are not sufficient to clearly describe the scope of an inventory, an entity should report any additional descriptions about the food categories in as much detail as practical. Two other sources are available that provide more detailed globally applicable classification of food categories. One is the Global Product Category (GPC) codes available via GS1,[24] and the other is the United Nations Standard Products and Services Code (UNSPSC), which is managed by GS1 for the United Nations. The two systems complement each other and do not overlap. The GPC provides detailed classification attributes and values for products primarily in retail trade and its use is free.[25] In contrast, UNSPSC provides a global classification frame-

work for all products and services in all industry sectors. The relevant part of the framework for FLW purposes is Segment: 50000000, which lists all the "Food Beverage and Tobacco Products." A free PDF version of the UNSPSC Codeset is available at the UNSPSC website through the "codeset-downloads" tab (members of UNSPSC also have access to a searchable database).[26]

Considerations related to changes in an item's intrinsic water content

As a particular item moves through the food supply chain, its weight may change. This is often a result of biological processes that, over time, reduce an item's intrinsic water content.[27] Its water content may also change due to various forms of processing, which can cause the water content to be:

- increased through processing or methods of food preparation (e.g., cooked rice or pasta, juice reconstituted from a concentrate); or
- reduced if heat is applied or an item is otherwise dehydrated (e.g., baked cookie dough, dried grain or fruit).

Because changes in the intrinsic water content may significantly affect the weight of an item, an entity may want to report additional details about the state of an item (e.g., whether the FLW inventory includes dried pasta or cooked pasta, juice concentrate or reconstituted juice, dried apples or fresh apples). An entity should decide whether this additional level of detail is useful, based on the accounting and reporting principles described in Chapter 5, in particular whether the information it provides is relevant (i.e., serves the decision-making needs of the inventory's intended users).

Considerations related to describing multi-ingredient items

For an entity (e.g., a restaurant or retailer) interested in understanding what types of food make up its FLW the GSFA, CPC, GPC, or UNSPSC codes may not provide sufficient detail for items that are composed of multiple ingredients (e.g., prepared meals, soup). In that case, an entity should describe such items with a commonly used name (e.g., beef stew) that would be understood by those for whom the FLW inventory is being prepared.

If additional information about the individual ingredients is relevant to the decision-making needs of an inventory's intended users, an entity may also describe the ingredients when reporting on its FLW inventory. Instead of describing all ingredients, it may be more practical for an entity to select the main ingredient(s) that represent a significant proportion of the item's overall weight (e.g., for beef stew this might be beef, broth, onions, and potatoes). An entity can most likely describe the individual ingredients using codes from the GPC or UNSPSC.

GUIDANCE: REPORTING ON "ORGANIZATION"

There is no globally accepted system of classification available to describe the organizational unit for which an amount of FLW is being reported. Users of the *FLW Standard* should at a minimum report on the number and type of "FLW-producing units" and use their professional judgment in providing a description that is detailed enough for their intended audience.

An "FLW-producing unit," for the purpose of the *FLW Standard*, is the discrete entity that generates FLW. Examples include a household, a business, an individual site (e.g., a production site, a grocery store), or a known area of agricultural land. In an FLW inventory, it is the amount of FLW from all these units over a given period of time that will be quantified. The "organization" describes the totality of FLW-producing units that are included in a particular inventory report.

In some cases, no additional detail will be required for the "organization" component of the boundary. For example, when the FLW being reported has a boundary of "all food categories" (for food category) and "all economic sectors" (for lifecycle stage), and "entire country" (for geography) there is nothing further to be added by describing the organizational unit.

In reporting on the "organization," an entity should describe which parts of its operation are included. Transparency will enable consistent tracking and comparability. Distinctions should be made with the decision-making needs of the intended users in mind and disclosed as clearly as possible. To illustrate:

- A producer may harvest crops from multiple fields but own only some of them. It should report whether the FLW inventory includes FLW from leased fields, or only from fields owned by the producer.
- A restaurant operator may report on FLW from multiple sites. If some of its sites are franchised, it should report whether its FLW inventory includes FLW from the franchised units, or only from the sites it owns. Moreover, a restaurant typically has two parts of its facility that generate very different types and amounts of FLW ("back-of-the-house," kitchen preparatory pre-consumer FLW, and "front-of-the-house" post-consumer FLW). It should also report which types of FLW generation are included in the inventory if quantifying pre-consumer and/or post-consumer FLW.
- A food manufacturer may report for all its wholly owned subsidiaries as well as a jointly owned operation.
- A municipality that quantifies FLW from households should report whether FLW is from only particular types of household. It may, for example, have been able to quantify only the amount of FLW generated by single-family residences.

With these examples in mind, businesses may consider distinguishing among three types of operations:

- operations that make up an entity's primary business (e.g., owned supermarkets);
- owned or controlled operations that exist in support of the primary business (e.g., a dairy or bakery owned by a supermarket); and
- operations not owned or controlled by the entity but under its banner or otherwise linked (e.g., franchised supermarkets).

Where other identification systems exist, these may also be used. For example, where a farm is audited, the certification body may have an identification system (e.g., farms certified through GLOBALG.A.P. have a GGN [GLOBALG.A.P. Number] that could be used). Industry sectors or others may also create new schemas that are relevant to their situation.

Box 6.2 describes how the organizational boundary of an FLW inventory could be described for a hotel chain. In this example, the entity would be reporting on the combined sum of multiple streams of FLW from different types of FLW-producing units. Other examples on how to report on the organization are provided in Table 6.3.

Box 6.2 | Illustrative Example of the "Organization" of a Hotel Chain

A hypothetical hotel chain operates 50 hotels, 30 of which are owned and 20 franchised. If the hotel chain's FLW inventory is based only on FLW produced at its owned operations, the reported organization boundary would be "30 owned hotels."

If the hotel chain's goal is to compare the FLW inventories of its owned hotels over time or compare its entire inventory against other hotel chains, it should also include in its description the total number of locations (or outlets) that are FLW-producing units and the type of operation for each hotel (e.g., a full-service restaurant, buffet bar, in-room dining service) because the amount of FLW differs by type of operation. It should also report which types of FLW generation are included (pre- and/or post-consumer FLW) since these two parts of a hotel's operations generate different quantities of FLW with different characteristics.

With the added detail included, the "organization" of its FLW inventory would be reported as "30 owned hotels; 45 locations (10 full-service restaurants, 20 buffet bars, 15 in-room dining services), pre- and post-consumer FLW from all locations."

6.7 Related Issues

Users should take into account a number of related issues when reporting on the scope of a particular FLW inventory.

PACKAGING AND OTHER NON-FLW MATERIAL

FLW may enter the path to a destination mixed with other material (e.g., inorganic items such as packaging,[28] or organic material such as grass clippings). In such a "mixed stream," users of the *FLW Standard* **shall** exclude from an FLW inventory any material (and its weight) that is not food and/or associated inedible parts removed from the food supply chain.

If a calculation is needed to separate the weight of FLW from non-FLW materials (e.g., subtract the weight of packaging), users of the standard **shall** describe the approach and calculation used. If possible, an estimate of the uncertainty associated with the estimated FLW data should also be made (see Chapter 9).

An entity could estimate the amount of FLW, as distinct from non-FLW material, by:

- carrying out a waste composition analysis to separate and weigh the various components in the mixed stream;
- using an inference-based method (e.g., a model, mass balance, or proxy factors) to estimate the proportion of FLW in the mixed stream; or
- undertaking a survey or diary to collect data.

These approaches to quantification are described in Section 7.2. In many situations, FLW that requires quantification will still be in its packaging (e.g., yogurt in its container), will be mixed with packaging (e.g., food scraps and wrapping mixed together in a collection container), or data relating to FLW will include the weight of the packaging. Section 8.3 provides more detailed guidance on excluding the weight of packaging from the amount of FLW.

WATER ADDED TO, OR REMOVED FROM, FLW

The weight of FLW reported by users of the *FLW Standard* **shall** reflect the state in which the FLW was generated before water was added, or before the intrinsic water weight was reduced. If any calculations are needed to estimate the original weight of the FLW, users **shall** describe the approach and calculation used.

An entity may add water to FLW before it enters a path to a particular destination. This addition may occur as part of an on-site "waste-to-water" system or may be necessary to meet regulatory requirements for diluting the FLW before disposal. Water may also be used to wash a storage area or equipment in a food processing facility to meet production and safety standards, which results in FLW becoming part of the liquid waste stream.

If water is added to FLW, users of the standard are required to report on FLW *excluding* the added water. For example, if a brewery disposed of 100 liters of beer, diluted with 900 liters of water, into the sewer, it is required to report its FLW as only the 100 liters of beer (converted into the weight equivalent as required by the *FLW Standard*). If a calculation is needed to estimate the original weight of FLW, users of the standard are required to describe the approach used. The *Guidance on FLW Quantification Methods* provides guidance on quantifying FLW in situations where water is added (see appendix A), and on quantifying FLW that is flushed through pipes, for example, to the sewage system (see section 3.2.).

In other cases, an entity may remove water intrinsic to the FLW during storage, before it enters a path to a particular destination. The intrinsic water in FLW is frequently removed by foodservice operations that use a pulping or dehydrating system, which involves grinding, heating, or otherwise processing the FLW, in order to extract the water and reduce the space it takes up in the collection container and/or reduce the cost of subsequent disposal.

Reducing FLW's water content for the purposes of storage or disposal is different from the situation noted in Section 6.6 (see "Considerations related to changes in an item's intrinsic water content"), which focuses on describing

the nature of items when their water content increases or decreases as a result of preparation/processing methods or biological changes.

If water intrinsic to the FLW has been extracted, users are required to report the amount of FLW *before* the water was removed so that the weight of FLW reported reflects its state when it was originally generated. An example would be if a restaurant operator collects 200 kilograms of FLW but uses a pulper to reduce the FLW's intrinsic water weight. It is required to report its FLW as the original 200 kilograms, before the FLW was pulped. If it was not able to quantify the FLW before it was pulped, it may need to consult with the pulping system manufacturer to obtain a factor that can be used to convert the final weight of the pulped product back into a pre-pulped weight.

In some cases, it will be impractical or difficult for an entity to accurately estimate the amount of FLW prior to water being added or removed. For example, water may be added at a processing plant to flush residual FLW from pipes and vessels to the sewer at the completion of a production run, or water may be used to move FLW into a storage container.

Users of the *FLW Standard* may decide whether to include or exclude such amounts of FLW in their inventory (or account for any natural decrease in weight during storage, prior to quantification) based on the accounting and reporting principles described in Chapter 5, in particular considering whether this choice would compromise the principle of "relevance" (i.e., the decision-making needs of the intended users).[29] The processing plant described above, for example, may decide to exclude from its inventory the residual amount of FLW flushed from pipes if excluding this amount does not meet a *de minimis* threshold, or will not have a material impact on the overall weight of FLW reported.[30] Users of the *FLW Standard* are required to document and justify this exclusion.

Alternatively, the processing plant may include this stream of FLW to ensure the relevance and completeness of the inventory, but shall then document the calculation approach used. It may use a less accurate approach for quantifying this amount, if necessary, provided that the inventory is transparent about reporting the approach and related limitations.

PRE-HARVEST LOSSES

This version of the *FLW Standard* does not include provisions for quantifying losses that occur pre-harvest (the stage in food production that occurs before a raw material for food is ready for harvest or slaughter). A separate process would be needed to develop a pre-harvest standard and/or guidance, which may be addressed in future work by the FLW Protocol. Users of the *FLW Standard* **shall** therefore exclude pre-harvest losses from the scope of their FLW inventory to be in conformance with the standard.

> *Users of the* FLW Standard *shall exclude from an FLW inventory any material (and its weight) that is not food and/or associated inedible parts removed from the food supply chain.*

While some guidance included in the *FLW Standard* may be relevant to quantifying losses pre-harvest, this standard was not developed with this in mind and methods for quantifying pre-harvest losses were not tested during the development process.

Quantifying pre-harvest losses differs from quantifying other losses at harvest and later stages, largely because it looks at "lost opportunity" rather than "loss of a tangible item." Addressing pre-harvest losses is about maximizing potential, whereas addressing losses of material ready for harvest/slaughter, or in subsequent stages of the food supply chain, is about minimizing loss or waste. These are different phenomena. Measuring performance at pre-harvest involves calculating a theoretical amount (the maximum yield potential) and then measuring the actual amount ready for harvest. It is "theoretical vs. actual." By comparison, measuring performance at harvest (or later) involves measuring how much was actually ready for harvest and then measuring the actual amount removed from the food supply chain. It is "actual vs. actual."

Understanding and quantifying losses that take place pre-harvest, however, can be relevant to increasing the availability of food for human consumption. Furthermore, what happens pre-harvest, such as weather or pest-related damage to crops, may contribute to FLW at harvest and beyond. The standard recommends that users collect and record information about causes of FLW, which might therefore capture factors that take place pre-harvest.

Users of the *FLW Standard* may nonetheless choose to quantify pre-harvest losses in order to meet their particular goals but **shall** keep this data separate from the FLW inventory results.

STARTING POINT OF THE FOOD SUPPLY CHAIN

The food supply chain (FSC) is defined as the "connected series of activities to produce, process, distribute, and consume food." For the purposes of the *FLW Standard*, the verb "produce" refers to the point at which the raw materials for food are ready for harvest or slaughter (i.e., ready to enter the economic and technical system for food production or home-grown consumption).

Examples of what might be considered "ready for harvest or slaughter"[31] include the following:

- Crops that are harvest-mature or suitable for their purpose
- Fruit and berries that are mature for harvest
- Wild crops, fruit, and berries that are harvested
- Animals ready for slaughter
- Wild animals caught or killed (live-weight)
- Milk drawn from the udder
- Eggs laid by the bird
- Aquaculture fish mature in the pond

The point in the food supply chain that an entity uses for its particular scope will be described in its reporting on the "lifecycle stage" (see Table 6.2a).

6.8 The Influence of Goals

An entity should choose a scope for its FLW inventory that is aligned with its underlying goals for addressing FLW. Table 6.4 provides illustrative examples of various goals, and their possible implications for the scope of FLW inventories selected by different entities.

As a global reference point, the UN Sustainable Development Goal Target 12.3 states, "by 2030 halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses."

Table 6.4 | Illustrative Examples of Goals and their Implications for FLW Inventory Scope

ENTITY	TYPE OF GOAL	ILLUSTRATIVE GOAL	IMPLICATIONS FOR FLW INVENTORY SCOPE	
			MATERIAL TYPE	DESTINATION
A national government	Food security	Increase food availability by reducing FLW by 30% by 2030	Food	All 10 destinations
Regional government	Environmental	Increase resource efficiency and reduce greenhouse gas emissions by 25% by 2030	Food; Associated inedible parts (separate quantification)	All destinations except animal feed and bio-based materials
A national food manufacturer trade association	Economic and environmental	Reduce food-related loss and waste from processing plants by 25% by 2025 in order to save money on waste collection and conserve natural resources	Food; Associated inedible parts (separate quantification)	All
A large grocery retailer	Economic	Reduce FLW going to landfill by 50% by 2025 in order to reduce tipping fee costs	Food and associated inedible parts	Landfill
A food manufacturer	Environmental	Work with suppliers in three provinces to reduce on-farm FLW of potatoes by 30%	Food and associated inedible parts	All
A soft drink manufacturer	Economic	Reduce quantities of product lost in wash water during batch change-over by 10% by using new technology	Food	Sewer/wastewater treatment
A city government	Environmental	Reduce FLW going to landfills by 90% and recover remainder for feed or energy by 2025	Food; Associated inedible parts (separate quantification)	Animal Feed Co/Anaerobic digestion Compost/aerobic Controlled combustion Landfill Sewer/wastewater treatment
A grower	Economic	Halve fruit and vegetable losses from harvesting through storage over the next five years to increase fruit and vegetable sales at market	Food and associated inedible parts	All

Table 6.4 | Illustrative Examples of Goals and their Implications for FLW Inventory Scope (continued)

ENTITY (REPEAT OF LIST)	IMPLICATIONS FOR FLW INVENTORY SCOPE (CONTINUED)				
	TIMEFRAME	BOUNDARY			
		FOOD CATEGORY	GEOGRAPHY	LIFECYCLE STAGE	ORGANIZATION
A national government	Annual	All food categories	Country	Entire supply chain	Country (all economic sectors)
Regional government	Annual	All food categories	EU Member States	Entire supply chain	28 countries (all economic sectors except primary production)
A national food manufacturer trade association	Annual	All food categories	Country	Processing (ISIC 1010–1080, inclusive)	All processing plants (70 member companies)
A large grocery retailer	Annual	All food categories	All countries in which retailer operates	Retail (ISIC 4721 and 4722)	All 500 stores managed by the retailer
A food manufacturer	Annual (quantified during harvest season and scaled up)	Potatoes	Selected provinces	Growing of vegetables and melons, roots and tubers (ISIC 0113)	All 20 farms supplying food manufacturer through dedicated purchasing contracts
A soft drink manufacturer	Monthly (to rapidly assess the effectiveness of the new technology)	Soft drinks	All locations of processing plants	Manufacture of soft drinks; production of mineral waters and other bottled waters (ISIC 1104)	All 100 manufacturing plants
A city government	Annual	All food categories	City	All economic sectors producing FLW (household, retail, catering/food service, manufacturing)	All FLW-producing units
A grower	Annual (quantified during harvest season and scaled up)	Fruits and vegetables	Location of farm	Two stages: 1. Growing of vegetables and melons, roots and tubers (ISIC 0113); growing of perennial crops (ISIC 0121–0129 inclusive); 2. Warehousing and storage (ISIC 5210)	Five fields

7. Deciding How to Quantify FLW

REQUIREMENT

Describe the quantification method(s) used and, if existing studies or data are used, identify the source and scope

This chapter is designed to help an entity decide how to quantify FLW. As noted in Section 2.4, users of the *FLW Standard* are required to account for the physical amount of FLW, expressed as weight.

The *FLW Standard* does not require that an entity use a particular quantification method because the quantification method(s) it chooses will be influenced by its particular goals, the scope selected for its FLW inventory, the human and financial resources available, and whether it has direct access to the physical FLW. However, in order to help an entity select the most appropriate method(s) under different scenarios, an FLW Quantification Method Ranking Tool is available at www.flwprotocol.org.

Users of the standard are advised to read this chapter in its entirety before deciding how to quantify FLW because there are multiple factors that can influence an entity's choices. The companion document, *Guidance on FLW Quantification Methods*, provides detailed guidance regarding how to use each of the quantification methods introduced in this chapter.

7.1 Selecting a Method for Quantifying FLW

An entity should first assess existing data that might be appropriate for an FLW inventory before investing time and resources to collect new data. Studies or collated data (in-house or external) that meet some or all of an entity's quantification goals may already exist. If no existing data are appropriate, a range of methods can be used to undertake a new quantification. For some entities, data on the amount of FLW will need to be gathered from multiple sources. Users of the *FLW Standard* **shall** describe the quantification method(s) used and, if existing studies or data are used, **shall** identify the source and scope.

GUIDANCE: USING EXISTING FLW STUDIES AND DATA

If an entity considers that existing FLW data may be appropriate, it should review the data and the study parameters carefully before using the data. There are two important aspects to be considered.

The first is whether the scope of the existing data matches the scope of the FLW inventory being developed. It is important to consider whether the same timeframe, material types, destinations, and boundary were used. For example, if an entity intends to report the material types separately (i.e., distinguishing between food versus associated inedible parts), it should confirm that the existing FLW data has used a framework to categorize food versus associated inedible parts that is the same as the entity's desired categorization of material types.

The second is whether the data are reliable enough to be used. The reliability of existing data is strongly related to the degree of uncertainty (including any biases) associated with it. The uncertainty is determined by several factors, including the choice of quantification methods and methodological details, such as sampling procedures. Guidance on sampling procedures is included in Appendix A and guidance on evaluating uncertainty is provided in Chapter 9. High-quality studies will list the sources of uncertainty and describe their likely impact on the results (quantified where possible). This allows an entity to assess whether the data from the study can be used for its purposes. In some cases, the degree of uncertainty can be high enough that an existing study should not be used.

In other cases, the data may not be exactly what an entity needs but may come very close, in which case they can be used as the basis of calculations to inform the FLW inventory. For example, a city could determine that the amount of FLW per capita is unlikely to have changed from one year to the next but that the population has increased. Assuming that the scope of its FLW inventory has remained the same, the city could use the prior data for FLW per capita and scale it up using the more recent population figure.

Likewise, a retail chain that has calculated FLW by sales area (kg/m^2) for some stores could apply the same ratio to other stores if the scope of the inventory, store characteristics (e.g., types of products carried and sold), and FLW management practices are the same.

If the existing data do not meet all of an entity's quantification needs, the entity will need to explore how to collect the remaining data. Box 7.1 provides an example of an FLW study in which data were calculated by combining existing data with new measurements and estimates.

GUIDANCE: UNDERTAKING A NEW QUANTIFICATION OF FLW

There are multiple steps involved in undertaking a new quantification of FLW. An entity should begin with a clear sense of how it intends to use the results, including an understanding of the decisions or communications that will be based on them. It may prepare a scoping document to lay out the details as well as identify the specific parts of the FLW inventory for which data need to be gathered. This may include consideration of issues beyond FLW quantification that are of interest (e.g., why FLW occurs). A scoping document can help ensure that an entity identifies all of its needs at the design stage.

An entity's goals, scope, and resources will then influence whether it measures FLW, approximates it, or infers the amount by calculation. An entity may combine these three different ways of quantifying FLW data to meet its goals.

Measurement and Approximation

Measurement is the most direct way to quantify FLW. It involves determining the amount of FLW by using an instrument or device marked in standard units or by comparing the FLW with an object of known amount. The results of measurement are expressed in weight,[29] unit count of items, or volume. The latter two require conversion to weight when preparing an FLW inventory in conformance with the *FLW Standard*, which can be done using standard factors but may introduce error. Guidance on converting count and volume to weight is provided in chapters 2 and 3, respectively, in the *Guidance on FLW Quantification Methods*.

Approximation is a type of quantification used to generate estimates that are close to the actual amount of FLW but less precise than a measurement. An entity may

Box 7.1 | Combining Data from Existing and New Studies

WRAP's *Household Food and Drink Waste in the UK 2012* study used two existing sources of data and a new study:

- Existing measurement data on the amount of material in various household waste streams
- Existing measurement data on the proportion of material in relevant household waste streams that was food
- New measurements and approximations of the amounts of food wasted by food type

approximate, for example, when measuring devices are not available. A "spoonful" or "plateful" may be used to approximate the amount of FLW in a household setting. In an agricultural setting, a "visual scale" may be used as one way to assess and approximate the loss of grain due to pest damage. A restaurant operator may know the size of a collection container (in cubic meters or gallons) and, based on how full it is, estimate the volume. This estimate can then be converted to a weight using bulk density factors. Given that there is a degree of subjectivity involved in making an approximation, the results are typically less accurate than if FLW had been measured.

Inference by calculation

Inference by calculation involves estimating the amount of FLW based on other data. It might take the form of deducing FLW from other relevant data (e.g., calculating the difference between food inputs and food outputs in a process such as food manufacturing). The amount may also be inferred by using models, which apply factors known to influence the amount of FLW (e.g., climatic or agricultural data). An entity may also infer FLW by using data from other entities (e.g. another country or another business) as a proxy to develop estimates of FLW.

Inference does not involve measuring or approximating FLW, although the data on which the inference is based are likely to have come from a prior measurement or approximation. For example, prior measurements may have been made of process inputs (e.g., the quantity of ingredients) or outputs (e.g., the quantity of products manufactured). Given that the amount of FLW is inferred, the accuracy of the resulting estimate is influenced heavily by the quality and accuracy of the original data chosen, as well as other assumptions on which they are based (e.g., the amount of ingredients [input] required to successfully manufacture a certain amount of product [output]). However, in most cases, inference by calculation will be less accurate than measurement of FLW, and possibly less accurate than approximation.

7.2 Overview of Quantification Methods

Table 7.1 outlines a suite of methods commonly used to quantify FLW. Each of these methods is described in greater detail in *Guidance on FLW Quantification Methods*. An entity may select whichever method(s) best meets its particular needs and may also choose to use methods not described in this standard.

METHODS FOR MEASURING AND APPROXIMATING FLW

Only entities that can get direct access to FLW will be able to use direct weighing, counting, assessing volume, or waste composition analysis as quantification methods. Weighing FLW usually produces the most accurate results because there is no guesswork and no need to make assumptions. This assumes, however, that an entity is able to use an appropriate device that delivers an accurate reading (e.g., weighing scales, pre-calibrated container). In addition, the increments on the scale should be sufficiently small for the amount of FLW being weighed (e.g., if FLW amounts are regularly smaller than 1 kilogram, a device that only provides information to the nearest 10 kilogram is not suitable).

An entity that cannot get direct access to the FLW may still be able to use a measurement or approximation-based method if it can ask for records, or FLW data, from the entities generating FLW. The accuracy of data collected through these methods (i.e., using records, diaries, and surveys) will vary depending on the nature of the data and the way in which they are collected and analyzed. For example, an industry association may decide to collect data from its members through a survey, but the accuracy of the FLW inventory results will be much higher if the members provide weight-based raw data on the amount of FLW than if they provide estimates that are rough approximations. Similarly, data will be more accurate where fewer assumptions or calculations have to be made.

Table 7.1 | Methods of Quantifying FLW

	METHODS	DEFINITION
MEASUREMENT OR APPROXIMATION An entity can use these methods if it can get direct access to the FLW	**1. Direct weighing**	Using a measuring device to determine the weight of FLW
	2. Counting	Assessing the number of items that make up FLW and using the result to determine the weight; includes using scanner data and "visual scales"[a]
	3. Assessing volume	Assessing the physical space occupied by FLW and using the result to determine the weight
	4. Waste composition analysis	Physically separating FLW from other material in order to determine its weight and composition
	5. Records	Using individual pieces of data that have been written down or saved, and that are often routinely collected for reasons other than quantifying FLW (e.g., waste transfer receipts or warehouse record books)
	6. Diaries	Maintaining a daily record or log of FLW and other information
	7. Surveys	Gathering data on FLW quantities or other information (e.g., attitudes, beliefs, self-reported behaviors) from a large number of individuals or entities through a set of structured questions
INFERENCE BY CALCULATION	**METHODS**	**DEFINITION**
	8. Mass balance	Measuring inputs (e.g., ingredients at a factory site, grain going into a silo) and outputs (e.g., products made, grain shipped to market) alongside changes in levels of stock and changes to the weight of food during processing
	9. Modeling	Using a mathematical approach based on the interaction of multiple factors that influence the generation of FLW
	10. Proxy data	Using FLW data that are outside the scope of an entity's FLW inventory (e.g., older data, FLW data from another country or company) to infer quantities of FLW within the scope of the entity's inventory

[a] Visual scales are practical pictorial aids used in agricultural contexts, typically to help assess the different levels of damage by pests to stored crops

Even if an entity does have direct access to the FLW, it may select a records-based method, diary, or survey if that better suits its overall goals for quantifying FLW. For example, if an entity wants to collect information about causes of FLW or information about behaviors, then a diary-based method may be more appropriate than—or an effective complement to—a weighing-based quantification.

METHODS FOR INFERRING FLW BY CALCULATION

If the entity cannot get direct access to the FLW and cannot obtain records or other FLW data that are based on measurement or approximation, it will need to infer the amount of FLW through a calculation. Even an entity with access to the FLW may choose to use an inference-based method for reasons of cost effectiveness or an inability to overcome some of the practical challenges of measurement and approximation.

Inference involves taking existing data and manipulating it computationally to produce estimates of FLW. In many instances, the data on which the inference is based will not have been collected by the entity using them. It is therefore important to understand the background to the data and ensure that they are appropriate to the scope of an entity's inventory.

Entities using inference-based methods should attempt to quantify the uncertainty associated with their estimates. Sometimes, the nature of the calculations (and their assumptions) and the quality of the data used are such that the estimates of FLW are not precise enough to meet an entity's needs. Deciding the level of acceptable uncertainty is a matter of judgment and depends on how the estimates are being used. Guidance related to assessing uncertainty is provided in Chapter 9.

CONSIDERATIONS IN SELECTING AMONG THE DIFFERENT TYPES OF QUANTIFICATION

Whether an entity decides to measure, approximate, or infer by calculation the weight of FLW will be influenced by several factors, including its quantification goals, level of desired accuracy, degree of access to the FLW, resources available, and practical considerations. Table 7.2 elaborates on how these issues may affect the type of quantification selected and are incorporated in the FLW Quantification Method Ranking Tool at www.flwprotocol.org.

Table 7.2 | Issues that Affect an Entity's Use of Different Types of Quantification

ISSUE	CONSIDERATIONS
Level of accuracy desired	In most situations, a measurement will result in a quantification of FLW that is more accurate than an estimate based on approximation; and both are typically (although not always) more accurate than FLW calculated by inference
Degree of access to the FLW	If an entity can get access to FLW it will be able to measure or approximate its weight; if not, it will have to use a method that is based on inferring the weight through a calculation
Resources available	Measuring and approximating data often require more staff time and budget (as well as access to the FLW) compared to inferring FLW through calculations
Practical aspects	For measurement or approximation to be feasible, an entity needs to consider a number of aspects such as the availability of power for electronic measurement devices; space for pre-sorting mixed material to separate out the FLW; and how FLW might be moved, stored, and sampled
Goals of quantification extend beyond the amount of FLW (e.g., understanding causes of FLW)	Methods based on inference by calculation typically do not offer the ability to expand beyond quantifying the amount of FLW but methods based on social-science research practices (e.g., diaries, surveys) are well suited to gathering additional information

PART III
OTHER REQUIREMENTS AND RECOMMENDATIONS

The chapters in Part III set out the requirements and guidance of the *FLW Standard* related to collecting, calculating, and analyzing FLW data (Chapter 8), assessing uncertainty (Chapter 9), and reporting an FLW inventory (Chapter 13); they also provide guidance on the requirements that apply if an entity undertakes assurance or review of an FLW inventory (Chapter 12), and if an entity tracks the amount of FLW or sets an FLW reduction target (Chapter 14).

In addition to providing guidance on how to implement the requirements, Part III also includes chapters that provide recommendations and guidance to users of the *FLW Standard* seeking to coordinate multiple FLW inventories for further analysis (Chapter 10), and record information about causes of FLW (Chapter 11).

8. Collecting, Calculating, and Analyzing Data

REQUIREMENT

If sampling and scaling of data is undertaken, describe the approach and calculation used, as well as the period of time over which sample data are collected (including starting and ending dates)

This chapter provides guidance about collecting and calculating FLW data. The sections focus on:

- Sampling and scaling up data
- Quantifying material types (food and associated inedible parts) separately
- Accounting for packaging
- Combining or summing FLW data across multiple stages in a food supply chain
- Confidentiality considerations

8.1 Sampling and Scaling up Data

It is often neither cost-effective nor practical for an entity to measure (or approximate) all the FLW across all FLW-producing units that make up the scope of its FLW inventory. In this case, an entity may instead collect data on the amount of FLW from only a sample set of FLW-producing units and/or from a sample of the physical FLW. These data may then be scaled up to generate an estimate of the total FLW from all FLW-producing units within an entity's scope.

Users of the *FLW Standard* that undertake sampling and scaling of data to develop their inventories **shall** describe the approach and calculations used, as well as the period of time over which sample data are collected (including the starting and ending dates). It is important to distinguish between the requirement in this chapter to report the period of time over which the sample data were *collected* (e.g., six one-week periods with specific dates) and the requirement in Section 6.3 to report the timeframe for which the inventory results are being *reported* (e.g., the sample data may be scaled up to represent 12 months of data, in which case 12 months would be reported as the timeframe of the FLW inventory).

ABOUT SAMPLING FLW DATA

Sampling is the process of choosing to measure or approximate, over a given period of time, the amount of FLW from a subset of FLW-producing units within a population, or from a fraction of the physical FLW produced. An entity may undertake both these types of sampling, which involve the following.

- **Sample FLW-producing units**: The entity selects a subset of FLW-producing units that are representative of the entity's inventory scope and quantifies FLW from these units. The entity then scales up data from the sample units to reflect all FLW-producing units (the whole "population") within the inventory's scope.
- **Sample physical FLW**: The entity takes a sample from the physical amount of FLW produced and measures (or approximates) the weight of that fraction because it may not be practical to measure the entire physical amount of FLW within an inventory's scope. The entity then scales up the data from the sample of FLW to obtain an estimate for total FLW generated by the FLW-producing unit.

When undertaking sampling, an entity may need to take into account the differences in FLW generated over time (e.g., by asking the sampled FLW-producing units to provide data for different seasons of the year, or taking a series of physical samples across different weeks of the year).

An entity should also ensure that the FLW-producing units (or physical FLW sample) from which measurements or approximations are made are as representative as possible of all the FLW-producing units in the population (or all FLW generated by the FLW-producing unit). Obtaining a representative sample improves the accuracy of the FLW estimates for the inventory.

Appendix A provides general guidance on considerations relevant to obtaining a representative sample, selecting a sampling approach, and determining the appropriate sample size.

ABOUT SCALING UP FLW DATA

An entity will need to scale up data in situations where the data do not cover the whole population and/or timeframe of the FLW inventory. The "population" refers to all the units that generate FLW and are within the scope of the FLW inventory. The population may therefore be an individual site, multiple sites within a business unit, all businesses within a sector, all households in a city, all agricultural fields in a country, all economic sectors in a country, etc. The timeframe of the inventory represents the period of time for which FLW is being reported (recommended to be 12 months). However, an entity may sample FLW over a shorter period of time (e.g., one month, several one-week periods) and therefore need to scale up the data to reflect the full timeframe of the inventory. Appendix A provides guidance on the process of scaling up data.

If an entity does not have sufficient internal expertise to sample or scale up data in a way that produces statistically valid data, it should seek technical guidance from a qualified professional such as a statistician.

8.2 Quantifying Material Types (Food and Associated Inedible Parts) Separately

This section provides guidance on approaches to quantifying material types separately. As described in Chapter 6, a requirement of the *FLW Standard* is that users **shall** account for and report the material type included in their FLW inventory (i.e., food and/or associated inedible parts; see definitions in Box 2.1). A whole banana illustrates the distinction between these two material types. A banana has flesh, considered food, and skin, which in many cultural contexts is considered an associated inedible part.

An entity's quantification goals determine which material type(s) it will report. If it chooses to quantify separately the food or associated inedible parts removed from the food supply chain, the *FLW Standard* requires that an entity also describe:

- the approach used to separate the materials; and
- the specific conversion factors used, if applicable, and the source of these factors (see Appendix B for guidance on possible sources for conversion factors used for individual items).

APPROACHES TO QUANTIFYING MATERIAL TYPES SEPARATELY

An entity may select from several approaches when quantifying food removed from the food supply chain separately from any associated inedible parts. Figure 8.1 lists them in descending order of accuracy.

1. Separating material physically

FLW can be physically separated into the two material types—food and associated inedible parts—and then either one or both types of material (depending on what the entity wants to quantify) can be weighed or otherwise quantified. This approach is likely to be the most accurate among the three.

Separating material physically, however, can be labor-intensive and time-consuming, and therefore likely to be more costly than the other two approaches. It may also present practical difficulties, for example, by the time the FLW is quantified the items may be rotten or rotting, and extracting the associated inedible parts may be difficult and unpleasant.

2. Using conversion factors for individual items

Conversion factors can be applied to data about individual items. These conversion factors can be used to separate the proportion (by weight) of an item considered to be food from the proportion considered inedible.

An entity can develop its own conversion factor by physically separating and quantifying the material or it can use a factor based on data from a third party. Using a conversion factor based directly on the FLW being quantified will in most cases result in more accurate data than using one derived from third-party data. However, using a third-party conversion factor for individual items is usually less time-consuming and is feasible in a wider range of situations. The following illustrates these two ways of obtaining a conversion factor, using as an example a container of bananas. The entity (banana producer) is seeking to quantify the weight of banana flesh (the food) separately from the weight of banana skins (assumed to be the inedible part).

The banana producer could develop its own conversion factor by weighing a representative sample of bananas, then peeling them and weighing the skins separately. The producer would calculate the percentage of the total weight represented by the skin, and use this percentage as the conversion factor in estimating the weight of banana skins for the entire container.

If it is not practical for the banana producer to select a representative sample and physically separate and weigh the banana skins, then the producer could apply a conversion factor based on third-party data to estimate the weight of flesh and the weight of skin. Several sources exist from which the producer could select a conversion factor. One is the United States Department of Agriculture's (USDA) National Nutrient Database for Standard Reference (NNDSR), which estimates that the skin of a banana eaten by Americans represents 36 percent of the weight of a whole banana.[33]

To improve the accuracy of estimates, an entity should record information on items in sufficient detail that appropriate factors can be applied. For example, if a whole banana is thrown away, the inedible fraction would be estimated as 36 percent (using the NNDSR conversion factor). However, if the banana was eaten and the peel thrown away, the inedible fraction is much higher (close to 100 percent if all the flesh has been consumed). Therefore, if conversion factors are applied, it is important that sufficient detail about the state of the item as it leaves the food supply chain is known.

More guidance on selecting data sources for conversion factors applied to individual items is provided in Appendix B. Table 8.1 provides an example of how an entity may report information about conversion factors for individual items and the related third-party source.

Figure 8.1 | Approaches for Quantifying Material Type Separately

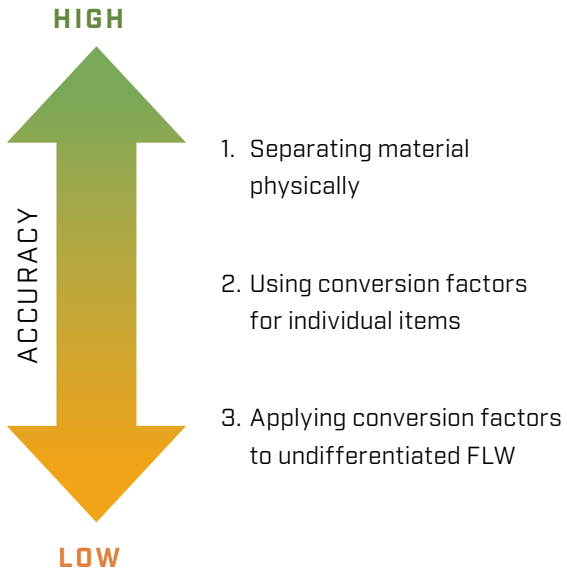


Table 8.1 | Illustrative Examples of Reporting Conversion Factors for Individual Items

ITEM	PART(S) CONSIDERED INEDIBLE FOR FLW INVENTORY	FACTOR USED TO ESTIMATE WEIGHT OF INEDIBLE PARTS SEPARATELY FROM WEIGHT OF WHOLE ITEMS (%)	SOURCE
Apple (peeled and used for cooking)	Core, stem, peel	23% (Based on "core / stem" = 10% plus skin = 13%)	USDA, NNDSR [a]
Banana	Skin	36%	USDA, NNDSR
Chicken breast, boneless	Bone, skin	28% (Based on bone = 19% plus skin = 9%)	USDA, NNDSR

[a] U.S. Department of Agriculture, National Nutrient Database for Standard Reference.

3. Applying conversion factors to undifferentiated FLW

If the FLW contains a mixture of items that cannot be differentiated or sorted, then an entity will not be able to either physically separate the material or apply conversion factors to individual items. This may be the case, for example, at a facility that has collected FLW produced by thousands of households, where FLW is a mix of multiple items that are not easily identified.

However, it may be possible for an entity to apply a conversion factor to the undifferentiated FLW in order to estimate the proportion of inedible material. As with less complicated FLW streams, an entity may develop its own conversion factor, or use one developed by a third party. For example, a quantification of household waste might apply the factor(s) used to quantify household waste in another country. The accuracy of this approach is affected by several variables that include whether the two countries categorize in a similar manner what is food versus inedible parts, and whether households in each country have similar diets and food preparation habits.

Box 8.1 describes a hypothetical example to illustrate the potential difficulty with using a third-party conversion factor.

The situation described in Box 8.1 underscores the importance of using a third-party conversion factor that aligns closely with an entity's circumstances, and the need to gain a clear understanding of the details associated with any third-party conversion factors selected. In some circumstances, there may not be a third-party conversion factor that aligns closely enough with an entity's circumstances to make it useable for estimating food separately from inedible parts.

If an entity is interested in monitoring changes in FLW over time and intends to use third-party conversion factors to separate the material into food and inedible parts, it should ensure that there is consistency over time in the methods and assumptions used to develop the third-party conversion factor so that shifts in reported FLW are not a result of shifts related to the third-party's conversion factor.

Box 8.1 | Potential Pitfall of Using a Third-Party Conversion Factor: A Hypothetical Case Study

A restaurant chain company would like to understand the amounts of FLW generated from its kitchens to see whether there is potential to reduce the amount of food thrown away. The kitchens collect FLW separately from other non-FLW materials and accept both food and associated inedible parts (neither of which is disposed through other routes). A waste management company weighs the kitchen waste upon collection and reports the total weight to the restaurant chain company. To understand the split between food and inedible material, the restaurant chain is considering applying a conversion factor used by a rival company that has published this information.

The rival chain, however, cooks mainly from scratch and therefore generates a large amount of inedible material resulting from preparation. Furthermore, it has already rolled out a wide-ranging waste-prevention training course for its kitchen staff and has reduced the proportion of food in its waste stream. As a result, the percentage of inedible parts in its waste stream is high.

By contrast, the chain of restaurants mainly uses semi-finished items in the kitchen and therefore generates much lower shares of inedible material in its preparation waste. The application of the rival restaurant's conversion factor for inedible parts to the FLW generated by the restaurant chain company, therefore, would lead to a much higher, and inaccurate, estimate of inedible FLW and could lead to inappropriate management decisions.

8.3 ACCOUNTING FOR PACKAGING

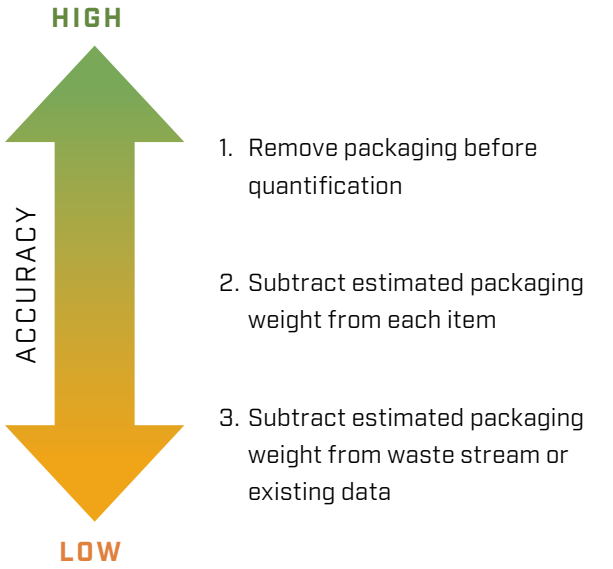
The definition of FLW does not include packaging such as boxes, wrapping, or plastic containers (although edible packaging would be considered food because it is intended for human consumption). Therefore the *FLW Standard* requires an entity to exclude packaging from its FLW inventory. However, in many situations, FLW that requires quantification will still be in its packaging (e.g., yogurt in its container), will be mixed with packaging (e.g., food scraps and wrapping mixed together in a collection container), or data relating to FLW will include the weight of the packaging.

The definition of FLW does not include packaging such as boxes, wrapping, or plastic containers.

This section provides guidance on approaches for excluding the weight of packaging from FLW. Figure 8.2 lists three approaches for excluding the weight of packaging in descending order of accuracy.

The *FLW Standard* requires users to describe the approach used to obtain an estimate of FLW without packaging. Ideally, an entity should also estimate the uncertainty associated with the data (see Chapter 9 for guidance on estimating uncertainty).

Figure 8.2 | Approaches for Excluding the Weight of Packaging from FLW



1. Remove packaging before quantification

An entity will obtain the most accurate estimate of FLW by quantifying it with the packaging removed (e.g., de-packaging the item, and weighing it separately from its packaging). This might be done in the following ways:

- in conducting a waste composition analysis, an entity could require that packaging removal be part of the sorting procedure;
- if collecting data through diaries, an entity could instruct the person keeping the diary to remove the packaging; or
- if using scanning information, an entity could ensure that the weight of items within the relevant database is net of packaging.

2. Subtract estimated packaging weight from each item

It is not always feasible to separate FLW from packaging. In some cases, separation is difficult (e.g., removing all the jam from a jar) or it can add to the cost of fieldwork (e.g., it takes longer to separate FLW from packaging in a waste composition analysis). Where separation from packaging has not been undertaken, an entity should estimate the FLW net of the packaging, which can be done as follows:

- subtract net printed weights on packaging for whole or unopened items. It is important to note that in some cases the actual weight of food may exceed the printed weight. In the UK, for example, it was found that the actual weight of unopened items was between 100 percent and 110 percent of the printed weight;[34]
- calculate the weight of a clean piece of identical packaging, and subtract it from the combined weight of the item and its packaging. This is possible where standardized packaging has been used and if an entity can confirm that the packaging used for subtraction matches the packaging containing the food; or
- make a visual estimate of the amount of FLW remaining and estimate its weight (e.g., where it is just a "scraping" of jam left in a jar). This is appropriate where the amount of FLW left in its packaging is relatively small and making a rough estimate is unlikely to affect the overall total greatly.

3. Subtract estimated packaging weight from waste stream or existing data

Where none of the approaches above is possible (e.g., if records, or prior FLW studies, are being used that include the combined weight of both the FLW and packaging) then the entity could assume the weight of packaging and subtract it from the total to calculate the FLW. This will produce a less accurate estimate of FLW but may be the only practical option available.

Two examples of this approach are given below.

- If the FLW of a retailer is collected for anaerobic digestion and includes packaged products, the facility doing the collection may be able to estimate the amount of packaging across its retail customers. This estimate could be used by the individual retailer, which would apply the "percentage of packaging weight" across its full waste stream to calculate the amount of FLW.
- If a combined estimate of household FLW plus packaging waste has been made for a country, and a separate estimate exists for household packaging waste in that country, then the latter could be subtracted from the former to obtain an estimate of household FLW for the country.

8.4 Analyzing FLW Data across Multiple Stages in a Food Supply Chain

An entity may wish to analyze FLW generated from multiple stages in the food supply chain. This may be from "farm to plate," for example, covering all stages from primary agricultural production to consumption. Alternatively, it may wish to analyze the FLW from consecutive activities within a particular stage. In the case of grains at the primary production stage, for example, an entity might be interested in analyzing FLW generated during harvesting, threshing, and drying activities.

It is good practice, when analyzing amounts of FLW across stages, to draw a flow diagram that illustrates the movement of food (and, if relevant, associated inedible parts) within and between stages. This enables an entity to document and visualize the flow of material types. It also helps to ensure that all relevant stages of the supply chain are captured.

It is important to keep in mind that the flow of food may be augmented or diminished at different stages of the supply chain (e.g., due to imports and exports, which could easily be overlooked). Moreover, an entity should understand the different types of food being produced, processed, or sold at the different stages (including confirming whether associated inedible parts [which may be referred to as by-products, or co-products]) are included in the calculations.

As the supply chain becomes more complex, the calculations that need to be performed may become more complicated. An entity may wish to reference the methodology of the FAO study "*Global Food Losses and Food Waste: Extent, Causes, and Prevention*" (2011) to see how calculations across supply chain stages were undertaken and documented.

An important consideration when analyzing the amount of FLW from consecutive stages is that percentages cannot be added up. An example of how to calculate and combine FLW across consecutive stages is provided below.

It is good practice, when analyzing amounts of FLW across stages, to draw a flow diagram that illustrates the movement of food (and, if relevant, associated inedible parts) within and between stages.

CALCULATING AND COMBINING AMOUNTS OF FLW ACROSS MULTIPLE STAGES

In the illustrative example in Table 8.2, the food supply chain starts with 1,000 metric tons (t) of food and associated inedible parts and generates a certain amount of FLW at each stage. In this simplified supply chain, there are five successive stages and any material that does not become FLW "flows" into the next stage. This example yields a total of 516.3 t of FLW. Expressed as a percentage (516.3/1,000), FLW accounts for 52 percent of the original material. (See Table 8.2, Column A.)

The percentage of FLW at each stage may be simply calculated (i.e., total FLW generated at that stage divided by total material entering that stage; see Column A). However, the total percentage of FLW generated across the stages in the food supply chain cannot be derived by summing the percentages from each stage. This is because the amount of total material entering each stage decreases with each successive stage. If the five percentages in column B were summed, this would yield 65 percent, which is incorrect (the correct amount being 52 percent). The total (cumulative) percentage of FLW must be derived by performing the calculation shown in Column C.

Table 8.2 | Illustrative Calculations of FLW across Stages of the Food Supply Chain

SUPPLY CHAIN STAGE	COLUMN A: Recorded FLW at each stage (starting with 1,000 t of product, i.e., food and associated inedible parts)	COLUMN B: % FLW by stage	COLUMN C: Cumulative % of FLW
Stage 1 Production	300 t FLW (out of 1,000 t)	30	30
Stage 2 Handling and storage	70 t FLW (out of 700 t)	10	37 (300 + 70)/1000
Stage 3 Processing and packaging	31.5 t FLW (out of 630 t)	5	40 (300 + 70 + 31.5)/1000
Stage 4 Distribution and market	89.8 t FLW (out of 598.5 t)	15	49 (300 + 70 + 31.5 + 89.8)/1000
Stage 5 Consumption	25 t FLW (out of 508.7 t)	5	52 (300 + 70 + 31.5 + 89.8 + 25)/1000
Total FLW	***516.3 t FLW = 52% FLW across all stages***	***Total percentages should not be summed***	

8.5 Confidentiality Considerations

An entity undertaking data collection or analysis of existing data should consider whether or not the data need to remain confidential. Many countries have laws covering data protection and data security. In addition, many professional bodies relating to social and market research have guidelines to safeguard the confidentiality of participants in a research study (whether an individual, business, or other organization). For example, stating the assumptions or contextual data used to generate FLW data might provide insights into market share that retailers regard as extremely confidential.

Entities sharing information as part of an FLW quantification study (e.g., suppliers asked to provide FLW information to a retailer) may also be concerned about confidentiality. These concerns could be addressed by using nondisclosure agreements, firewalls, or an intermediary entity tasked with making the data anonymous to protect the identity of suppliers who provide data.

9. Assessing Uncertainty

REQUIREMENT

Provide a qualitative description and/or quantitative assessment of the uncertainty around FLW inventory results

It is important to understand the degree of uncertainty inherent in FLW inventory results because uncertainty will affect both the interpretation of these results and the conclusions that can be drawn from them.

All quantifications of FLW will be subject to some degree of uncertainty. The degree of uncertainty describes the likely difference between the estimate of FLW (what was quantified) and the "true" amount of FLW, that is, the value that would be obtained from a perfect measurement. The difference between the two involves random uncertainties[35] (e.g., from sampling only part of the population and then scaling up the results) and biases (e.g., using a quantification method, such as a diary, that systematically underestimates FLW levels).

This chapter provides guidance on assessing and reporting uncertainty. The sections focus on:

- Reporting the degree of uncertainty
- Qualitative descriptions of uncertainty
- Quantitative assessments of uncertainty
- Considerations when communicating inventory results

9.1 Reporting Degree of Uncertainty

Clear communication about the degree of uncertainty and sources contributing to uncertainty increases the credibility of an entity's FLW inventory and gives users more confidence in its results. It also enables other entities to appropriately incorporate the inventory results into their own decision-making or FLW quantification studies. Moreover, identifying and documenting sources of uncertainty can help an entity understand the steps required to improve the quality of an FLW inventory.

Therefore, users of the *FLW Standard* **shall** report a qualitative description or quantitative assessment of the uncertainty of the results and, if feasible, report both. Users should make a thorough yet practical effort to communicate key sources of uncertainty in the results. When revisions of the FLW inventory are undertaken, an entity should also describe its efforts to reduce uncertainty. Users should provide as complete a disclosure of uncertainty information as possible.

9.2 Qualitative Descriptions

A qualitative description of uncertainty should list and describe the various sources of uncertainty assessed during the course of the study. A discussion of the potential impact of uncertainty on the results should also be described (if a quantified estimate is not provided).

There are many potential sources of uncertainty. Table 9.1 provides examples, along with recommended steps an entity could take to minimize them.

An entity should identify and track important sources of uncertainty throughout the process of preparing an FLW inventory. It may find value in listing the sources of uncertainty in a "working document" at the start of the process (even those sources that may later prove to be negligible in size). The list can be added to as additional sources of uncertainty are identified. If an entity can assess potential sources of uncertainty early in the process of quantifying FLW, it will be better prepared to minimize the degree of uncertainty in the results.

Table 9.1 | Sources of Uncertainty and Options for Minimization

POTENTIAL SOURCE OF UNCERTAINTY	DESCRIPTION	MODIFICATION OPTIONS TO MINIMIZE UNCERTAINTY
Systematic errors (bias)	Potential sources of bias include: ▸ Using a quantification method that systematically under- or over-estimates FLW (e.g., methods that rely on a respondent to recall the amount of FLW) ▸ Failing to calibrate "zero weigh" scales used for measurement ▸ Omitting one type of FLW-producing unit from a study (e.g., omitting apartments/flats when sampling all households in a population) ▸ Not covering all the FLW that is within the scope of the inventory (e.g., particles of FLW flushed down the drain during cleaning processes)	▸ Select a quantification method that provides a higher degree of accuracy (e.g., one based on weighing) ▸ Check the data capture instruments (at appropriate intervals) ▸ Carefully consider possible variations in the population being quantified ▸ If avoiding coverage discrepancies is not possible, consider whether adjustments can be made to the estimate to correct for any discrepancies
Methodological errors	Errors (procedural or quantitative) can be made during the process of quantifying FLW. For example: ▸ When scaling up the results from measurement or approximation ▸ When performing calculations within a model (e.g., using incorrect formulas) ▸ During a waste composition analysis, if processes are not in place to ensure that the sorting of FLW is done consistently	▸ Use the appropriate approach and factor for scaling up the data (see Appendix A) ▸ Perform checks at all stages of the calculations ▸ Put in place protocols (e.g., for sorting FLW and oversight of this process)
Data-processing errors	Errors could be made in populating databases or miscoding of items	Perform checks during data entry and on the final database/dataset
Converting amounts to weight	A degree of uncertainty is introduced when converting to weight from another measure (e.g., volume)	Choose a method where FLW is actually weighed (e.g., rather than where the volume is assessed visually then converted to a weight)
Assumptions	Assumptions sometimes need to be made in quantifying FLW (e.g., it may be assumed that change in weight due to evaporation during processing is negligible)	Explore the effect of these assumptions on the results (e.g., by undertaking a sensitivity analysis).[a] If the impact on the results is large, consider obtaining more accurate information to refine the assumption
Number of FLW-producing units in the sample	Uncertainty is introduced when only some FLW-producing units are selected for quantification. If the selection is random or close to random, then the uncertainty can be estimated as follows: $\text{Approximate 95\% confidence interval} = \text{mean} \pm 2 \times \frac{\text{standard deviation}}{\sqrt{\text{sample size}}}$	Investigate the likely level of sampling uncertainty due to the number of FLW-producing units sampled and change the number of units in the sample frame accordingly[b] In general, sampling more FLW-producing units (i.e., a larger sample size) will reduce uncertainty. The effect of appropriate sample sizes on uncertainty is covered in more detail in Appendix A

Table 9.1 | Sources of Uncertainty and Options for Minimization (continued)

POTENTIAL SOURCE OF UNCERTAINTY	DESCRIPTION	MODIFICATION OPTIONS TO MINIMIZE UNCERTAINTY
Approach used to select sample (see Appendix A)	If the selection of sampling units for the sample frame is not random, then this can introduce bias. For instance, if a disproportionately high number of large companies are sampled, and they have different levels of FLW compared to smaller companies (when compared using a normalization factor), then this will introduce a bias into the results	Consider stratified sampling and post-weighting of data to ensure that they are representative of the population
Non-response of FLW-producing units	FLW-producing units in the sample frame may not provide an estimate of FLW (which could be for a range of reasons). This can lead to non-response bias if those FLW-producing units that provide estimates have different levels of FLW compared to those that do not provide data	Depending on the data obtained, investigate the effect of non-response after the data have been collected and make adjustments to (partially) account for non-response bias
Temporal variation in FLW	The level of FLW may vary over the course of a week, a month, or a year. When the FLW is sampled, therefore, can influence the results	Adjust the sampling approach to avoid bias related to seasonal effects For instance, the amount of FLW in the home often varies based on the types of food bought at different times of the year. Ideally, sampling should be undertaken over the course of the year to ensure that the data are temporally representative
Uncertainty in data used for inference-based methods (e.g., mass balance)	The uncertainty in the estimate of FLW will be impacted by the uncertainties associated with the data used to develop the estimate of FLW (e.g., in a mass-balance calculation this would be the quantities relating to the inputs and outputs of a process)	Where possible, obtain or otherwise estimate the uncertainties around the data used in the calculation (e.g., the data on inputs and outputs) and track the propagation of these uncertainties through the calculation
Model uncertainty	Model uncertainty arises from limitations in the ability of the modeling approaches used to reflect the real world. Simplifying the real world into a numeric model always introduces some inaccuracies. In many cases, model uncertainties can be represented, at least in part, through the errors described above (e.g., uncertainty in "input" data and assumptions). However, some aspects of model uncertainty might not be captured by those classifications and are otherwise very difficult to quantify	Where possible, obtain or otherwise estimate the uncertainties for the data used (see *Guidance on Quantification Methods* for more details about using models)
Third-party data	The level of uncertainty is not always known when using data that come from other sources	Where possible, contact the "owner" of that data to see whether an estimate of uncertainty can be made. Alternatively, develop an estimate of the uncertainty based on similar data sources, or knowledge of the sample size, to understand the importance of the uncertainty for those particular data

[a] A sensitivity analysis involves adjusting the parameters (variables), or combinations of parameters, to understand the sensitivity of the overall results to changes in those parameters

[b] This type of analysis usually requires some knowledge of the variation in levels of FLW produced between FLW-producing units; this type of information may come from a previous study (e.g., one in a similar country) or a pilot study

If an entity seeks to compare and communicate the uncertainty of multiple FLW inventories, but quantitative assessments have not been undertaken, it may use a more qualitative approach. For example, an entity may create a simple rating to assess the degree of uncertainty, which could be based on the different sources of uncertainty described in Table 9.1, or some other factor. Rating scales can be created in various ways, depending on an entity's particular needs and priorities. The following are two possible examples:

- Scale based on estimated degree of uncertainty (ranked from lowest to highest uncertainty)
    1. Reasonably accurate data (± 0–10 percent estimated uncertainty)
    2. Somewhat accurate data (± 11–25 percent estimated uncertainty)
    3. High uncertainty (>± 26 percent estimated uncertainty)
- Scale based on types of quantification methods used and level of assurance undertaken to improve the degree of accuracy in the reported amount of FLW (ranked from lowest to highest uncertainty).
    1. Survey of entities with a large sample size and some measured elements, with extensive validation and assurance
    2. Survey of entities with a large sample size, and some measured elements, some validation of results, and assurance
    3. Survey of entities with a large sample size, and some measured elements
    4. Survey of entities with a large sample size
    5. Survey of entities with a relatively small sample size

    In the second hypothetical scale above, three elements are combined to develop the 5-point ranking: size of sample, existence of measurements, and degree to which assurance is given about the quality of these measurements. The uncertainty assumed to be associated with these elements is as follows:

    - Size of sample (high: small sample, low: large sample)
    - Recall versus direct measurement (high: recall, low: direct measurement)
    - Validation and assurance of figures (high: no validation/assurance, low: good validation/assurance)

9.3 Quantitative Assessments

A quantitative assessment of uncertainty can provide more robust results than a qualitative assessment and help an entity to prioritize data improvement efforts by targeting the sources that contribute most to uncertainty. When communicating about quantitative assessments of uncertainty, an entity should:

- identify the uncertainties being quantified (and provide a rationale for excluding those which are not being quantified); and
- present inventory results alongside a confidence interval reflecting the uncertainties that could be quantified.[36]

An entity can express a confidence interval for some sources of uncertainty. For example, sampling uncertainty is usually relatively straightforward to quantify. Confidence intervals (inventory result(s) ± X metric tons) can be presented with different levels of confidence (e.g., 95 percent, 99 percent confidence) and indicate different levels of accuracy. Different disciplines have a variety of conventions regarding the level of confidence that should be included. Many researchers use 95 percent confidence intervals, which describe the interval (or range) in which the results of 95 percent of these hypothetical calculations would be found if the study were to be repeated in

exactly the same way. If quantifying uncertainty, users of the *FLW Standard* should declare which level of confidence they are using.

In some cases, comparison will be made between two results (e.g., the amount of FLW from the same geographical area at two points in time). Where comparisons are made, the change over time or the difference between two entities should be reported alongside a confidence interval relating to this change/difference and/or a *p*-value[37] using calculations based on statistical methods.

When reporting comparisons, the results—together with the associated measure of confidence (the confidence interval or *p*-value)—should be presented, regardless of whether standard thresholds of confidence have been reached. For instance, where a result does not meet a requirement that the *p*-value is no greater than 0.05—which is equivalent to a 95 percent chance that there has been an actual change—it is still good practice to report the result, so that the reader can use the data in circumstances where it is appropriate to do so.

To illustrate, suppose an entity quantified its FLW as 500 metric tons (t) before, and 400 t after, an FLW-reduction intervention, and the *p*-value for this change was 0.06. Given that the change in FLW over the course of the intervention is the desired metric, it would be appropriate to report the change, and the *p*-value, together with guidance to the reader on how to interpret this change. Some researchers may consider this a "non-significant" result because it fails to reach the common threshold of $p \leq 0.05$. However, others may use a lower threshold[38] and meta-studies may be able to make use of results that fail to reach a certain threshold by combining results from multiple studies.

The level of uncertainty may be different for various quantities within a calculation. It is therefore important to ensure that the uncertainties are tracked as the calculation progresses. The following example shows how combining uncertainty affects the total result; this may also be referred to as "propagated parameter uncertainty."

In a mass-balance calculation, an estimate of 90 t (±10 t) for the outputs is subtracted from 100 t (±10 t) for the inputs. The result would be 10 t (±14 t) if the two errors are independent. The percentage error in the final result (±140 percent) is much greater than in the two original quantities (±11 percent and ±10 percent, respectively).[39] This is often the case when one quantity is subtracted from another. Tracking uncertainty can be accomplished through the use of equations describing the propagation of uncertainty in calculations[40] or use of methods such as Monte Carlo simulations.[41]

9.4 Considerations when Communicating Results

In addition to technical reporting, an entity may decide to communicate its findings to other (less technical) audiences to help engage the public, support decision-making, increase the credibility of the results, or achieve other purposes.

It is good practice for those responsible for developing communication products aimed at a lay audience to work closely with someone who understands the uncertainty associated with the results. This ensures that communications are backed up by the study's findings, original research is clearly referenced or linked, and the appropriate caveats concerning the findings are communicated.

For example, decisions about communicating changes in FLW should be guided by the confidence intervals and *p*-values calculated. To illustrate, the amount of FLW from households in one region might be 150 kg/person/year (±30 kg/person/year) which amounts to 120–180 kg/person/year. In another region, it could be 135 kg/person/year (±25 kg/person/year), which amounts to 110–160 kg/person/year. Because these results show little evidence of a difference between these two regions, an entity should not suggest there was a difference, even though there is a small difference of 15 kg/person/year in the main (central) estimate.

10. Coordinating the Analysis of Multiple FLW Inventories

This chapter provides guidance for an entity that is interested in analyzing and coordinating FLW inventory results across a number of inventories. There are two main reasons why an entity may want to coordinate inventories: to combine the amount of FLW from multiple entities, or to compare FLW among entities. For the purpose of the *FLW Standard*, entities playing this role are referred to as "coordinating entities." The sections focus on:

- Activities and goals of coordinating entities
- Specifying the scope and methodology across multiple inventories
- Guidance specific to coordinating a government-level inventory

A coordinating entity should pay particular attention to details about the scope and methodology of the FLW inventories analyzed. Differences between FLW inventory scopes and methodologies will affect the coordinating entity's ability to combine or compare results and draw accurate conclusions.

10.1 Activities and Goals of Coordinating Entities

The goals, and thus activities, of a coordinating entity may vary among entities. Table 10.1 lists several types of coordinating entities and illustrative examples of possible activities and related goals.

10.2 Specifying the Scope and Methodology across Multiple Inventories

The *FLW Standard* is designed to allow for differences in accounting and reporting decisions so that an entity can use its discretion in selecting the scope and quantification methods that best meet its goals. However, a coordinating entity seeking to make a comparison between individual FLW inventory results will not be able to draw any accurate conclusions if the inventories in question are based on different scopes.

Table 10.1 | Examples of Coordinating Entities and Illustrative Activities and Goals

COORDINATING ENTITY	ACTIVITIES AND POSSIBLE GOALS OF ANALYZING MULTIPLE FLW INVENTORY RESULTS
Industry association	▸ Sum the FLW from member businesses to develop a total FLW inventory for the whole sector and establish base year data for the entire association or sector
Individual business	▸ Sum FLW from multiple sites within a business unit to generate a total and set targets for reduction ▸ Sum FLW data from suppliers (upstream) and consumers (downstream) in order to develop an end-to-end view of FLW and identify priorities for action ▸ Compare FLW across business units for internal benchmarking (e.g., in order to identify "leaders and laggards" and prioritize opportunities for FLW reduction)
National government	▸ Sum data on FLW from all economic sectors as well as households within national borders to estimate total FLW for the country in order to prepare a national inventory and track reductions over time ▸ Compare FLW within certain sectors (e.g., a particular crop, households) to understand how FLW differs across the country (e.g., across sub-national regions, across ethnic groups) in order to prioritize the most useful interventions and application of resources
Intergovernmental agency	▸ Compare FLW among countries to assess progress toward reducing FLW and identifying where (and what) strategies are working

Even if the inventory scope is the same among multiple entities, these entities may nonetheless be using different quantification methods and assumptions due to practical considerations—such as budget availability—or differences in the level of accuracy each entity requires. The use of different quantification methods or assumptions can affect the degree of uncertainty in an entity's inventory results, and is another factor that can limit comparability.

In some cases, a coordinating entity may be in a position to instruct entities preparing an FLW inventory, and specify what FLW is to be quantified (the scope) as well as how it will be quantified (the method and assumptions). In these cases, it is good practice, where possible, for the coordinating entity to:

1. **Discuss the feasibility of implementing the desired specifications with personnel conducting the FLW inventories.** If a coordinating entity can discuss the design and preparation of an FLW inventory with the entity implementing it before the inventory is developed and conducted, it will help to ensure that the desired specifications can be and are followed. It can be challenging to retrospectively align the scope and methodological details of FLW inventories.
2. **Clearly document the specified scope, quantification method(s), and assumptions**. This provides those preparing the FLW inventory with written specifications to which they can refer.
3. **Incorporate a feedback mechanism.** A coordinating entity should encourage those preparing FLW inventories to provide feedback (e.g., if more details are needed about the scope and quantification methods), and it should update the documentation accordingly.

GUIDANCE: SPECIFYING SCOPE

Specifying the scope involves defining the information that is required, based on the components discussed in Chapter 6, and communicating this to entities developing FLW inventories. The components are:

- **Timeframe—**the period of time covered by the FLW estimates
- **Material type—**the type of materials to be accounted for (and whether food is to be quantified separately from associated inedible parts)
- **Destinations—**which of the 10 potential destinations of FLW are to be included (or excluded) in the FLW inventory
- **Boundary—**which food categories to include or exclude (e.g., whether to include drinks), lifecycle stage (which economic sectors to include), geographic borders that are relevant, and organizational unit(s) to be covered
- **Related Issues—**confirming that the weight of any non-FLW material (e.g., packaging) or pre-harvest losses must be excluded, and that the reported weight of FLW reflects the state in which it was generated (i.e., before water was added, or before the intrinsic water weight of FLW was reduced)

Examples of how an entity's goals might impact the scope selected for an FLW inventory are described in Section 6.8. A coordinating entity should define and communicate the specifications about scope with enough detail to enable the entities developing and reporting their individual FLW inventories to do so consistently. For example, if the scope is to exclude associated inedible parts, the coordinating entity needs to define what material is considered "inedible parts" in sufficient detail that there is no ambiguity for those undertaking the FLW inventory. Doing so will require the coordinating entity to take into account the cultural context in terms of what is considered food and what is considered inedible parts.

GUIDANCE: SPECIFYING QUANTIFICATION METHODS AND ASSUMPTIONS

In addition to specifying what FLW is to be quantified, the coordinating entity should also provide guidance on how FLW is quantified. For example, the coordinating entity should request that reporting entities sample appropriately if the data are to be scaled up (e.g., a food processor should be reporting on more than just one plant out of 200, assuming there is variability across its operations). The coordinating entity may also provide more detailed sector-specific instructions, including under what circumstances FLW

data from one FLW inventory may be used for another (e.g., if results based on one milk district are similar enough to other milk districts that they may be used to scale up the data to all the districts). If the coordinating entity combines the FLW generated from multiple stages in the food supply chain (e.g. covering all stages from primary agricultural production to consumption), it should refer to Section 8.4 for guidance about related approaches to calculation.

Table 10.2 summarizes a number of the quantification aspects that a coordinating entity may wish to specify.

10.3 Guidance: Coordinating a Government-Level FLW Inventory across Sectors

Governments at all levels—national, provincial, state, or city—may prepare an FLW inventory to determine the level of FLW within their jurisdiction. With this information, they can identify opportunities for reducing FLW, track the amount of FLW over time, or compare quantities of FLW with other government-level inventories to share knowledge about effective prevention and management strategies. This section provides guidance for preparing and coordinating a government-level inventory using data from multiple sectors.[42]

ESTABLISHING THE SCOPE OF A GOVERNMENT-LEVEL INVENTORY

A government-level inventory, like any other, begins with an identification of goals and a subsequent development of scope. Box 10.1 provides an example of scope for an FLW inventory to be conducted by a national authority.

UNDERTAKING A GOVERNMENT-LEVEL INVENTORY

Governmental authorities of all kinds, from national to city, should follow five steps when gathering FLW data from various economic sectors (e.g., primary production, manufacturing, retail and distribution, food service, and households).[43] If the study is to be repeated over time, it is useful to review its approach after the first assessment to identify how it might be improved or done more simply, efficiently, or cheaply in the future.

1. Review the scope of the sector(s)
2. Set up a work plan
3. Identify and review existing data
4. Select methodology for quantification
5. Undertake quantification using existing or new data

1. Review the scope of the sector(s)

The governmental authority should clearly define which sectors are to be included. This will follow from the scope established by the entity conducting the government-level inventory, whether that be the government or a sub-contractor who is undertaking the inventory on behalf of the government. (For the sake of simplicity, in this section we will refer to the entity undertaking the inventory as "the government.") If the quantification is aimed at identifying the amount of FLW going to a city's landfills, for example, all FLW-producing sectors would be included through all stages of the food supply chain. If a government is merely trying to understand how much FLW occurs in storage after harvest, then only the agriculture and storage sectors will be included. All sectors from primary production to household should be included, if the governmental authority wishes to track its progress toward UN Sustainable Development Goal Target 12.3.

The government should also make clear what is to be included in each sector. For example, if a city is quantifying FLW from grocery stores within the city, the inventory should state what is considered a grocery store for the purposes of the inventory (e.g., stores under a certain size might be excluded, or stores that sell food alongside other non-food items might be included).

For each applicable sector, the government should be familiar with the principal individuals, organizations, or companies within the sector. (This may not be necessary when looking at household-level FLW because it is more likely that the government will use a sampling approach for quantifying this sector.) These actors, as well as any representative bodies or trade organizations that are affiliated with the sector, will be an important resource for acquiring the necessary data to complete the inventory.

Table 10.2 | Quantification Aspects that May Be Specified by Coordinating Entity

ASPECT OF QUANTIFICATION	WHAT COORDINATING ENTITY MAY SPECIFY
Quantification method	▸ One single method that is to be used for all FLW inventory reports within a program or initiative. For instance, if quantifying household FLW, the coordinating entity (e.g., a national authority) may wish to specify use of waste composition analysis or diary-based approaches ▸ Methods that can be adapted (within bounds) to different situations. For example, a retail chain obtaining FLW information from its suppliers may wish to specify one method for agricultural suppliers and another method for food processors
Sampling (where appropriate)	▸ Sample size ▸ Approach to sampling (e.g., random, clustered random, quota). In the case of quota sampling, the coordinating entity should specify how to minimize bias ▸ Whether stratification of the sample is required and, if so, the details of this stratification ▸ Length of time to be measured by each instance of sampling (e.g., measuring one week's worth of FLW) ▸ Timing for undertaking sampling during the specified timeframe (e.g., how sampling will be distributed within a year) (Guidance related to sampling is provided in Appendix A)
Other methodological details	Depending on the method used, specification may include: ▸ Specific conversion factors to use (e.g., density factors when converting volume to weight) or specific sources of conversion factors (e.g., a specific dataset) ▸ How information is scaled to the population of interest (e.g., scaling per person, per m^2 of sales area, or other factor) ▸ For waste composition analysis, the mesh size used to separate larger items of waste from smaller items ▸ Where existing information is used (e.g., records from waste management companies), what quality threshold to use for including or excluding individual records (see chapter 5 in the *Guidance on FLW Quantification Methods*) ▸ Desired "level of confidence" in the data (see Chapter 9)

2. Set up a work plan

Governments at any level will have to undertake and keep track of many activities due to the large number of external organizations with whom it will have to coordinate. It is therefore important to set up a work plan, which will allow the government to anticipate the amount of work and resources that will be involved in developing the inventory.

A work plan should contain the following elements to be successful:

- list of activities aligned with the five steps outlined in this section;
- list of individuals, organizations, and companies within each sector that need to be contacted, along with information about primary contacts;
- list of what specifically is being requested of each organization and company within each sector (e.g., existing FLW data, waste management data);
- estimate of required resources (e.g., staff time, budget);
- timeframe for completion of each step; and
- identification of individual(s) responsible for undertaking each step.

Box 10.1 | Illustrative Example of Scope for FLW Quantification at the National Level

The following provides an example of the scope that a national authority (as coordinating entity) may require for each entity reporting FLW. In addition, it would likely need to include more detailed, sector-specific instructions.

- **Timeframe:** Collect data over the course of a calendar year
- **Material type:** Quantify both food and associated inedible parts

  The *FLW Standard* recommends that information on food be recorded separately from associated inedible parts, where possible. This provides national authorities with the option of analyzing (currently or in the future) the different material types separately
- **Destinations:** Include FLW sent to the relevant destinations (selected from among the 10 destination categories, and reported separately, if possible)

  A national authority seeking to maximize food availability and resource efficiency may want to include all 10 destinations. However, a different national authority focused on, for example, reducing organic matter that goes to landfill, controlled combustion, and the sewer may want to require that entities report only for those three destinations
- **Boundary:**
  - *Food category*—All food types and categories

    It can be difficult to quantify drinks, and entities preparing the inventories may need additional guidance on quantification methods
  - *Lifecycle stage*—Direct operations, which may be described in terms of an economic sector, food sector type, or household
  - *Geography*—Area within national borders
  - *Organization*—All FLW-producing units

    The organizational boundary should be representative of each reporting entity's total FLW. If certain units are not accounted for, however, the entity shall specify which ones are excluded. For example, if a municipality does not include the weight of FLW generated by multi-family residences in its inventory, it shall state this exclusion
- **Related Issues:** Confirm that the weight of any other non-FLW (e.g., packaging) and pre-harvest losses have been excluded, and that the reported weight of FLW reflects the state in which it was generated (i.e., before water was added, or before the intrinsic water weight of FLW was reduced)

This plan will help to prevent the task of developing the inventory from becoming overwhelming or disjointed.

3. Identify and review existing data

In some sectors, studies or collated data may already exist that meet a government's quantification goals. As described in Section 7.1., see "Guidance: Using existing FLW studies and data," the government must first determine whether the scope of existing data matches the scope of the FLW inventory it is preparing, meaning that the timeframe, material types, destinations, and boundary are the same. Second, the government should determine whether the data are reliable enough for use by assessing their level of uncertainty.

4. Select methodology for quantification

Once a government has reviewed existing data, it can decide how to go about collecting or quantifying the FLW of the sector(s) being examined. A government must make several decisions if it chooses to collect new data on FLW. Chapter 7 details many of these decisions, which relate to matters such as available resources, whether the government has access to the FLW, time constraints, and more. A specific decision that is unique to a government-level inventory is whether the quantification will be performed by the government (or its contractors) itself or by the organizations and companies within the sector.

The benefit of the government conducting the inventory is that all quantification undertaken in the study will be consistent. The potential downside is that a government is unlikely to have as much detailed knowledge of any particular sector as the individuals who actually work in the sector, which may cause potential oversights in the design of the quantification. Additionally, members of the sector may be reluctant to share data because of confidentiality concerns. This downside may be mitigated if the government uses contractors that have sector-specific knowledge and are independent. If the government chooses to delegate the task of quantification to the sector being studied, it should ensure that organizations and companies within the sector have, or can gain access to, the resources (financial, human) needed to collect the data.

Governments preparing the inventory should provide guidance to the sectors contributing data about which quantification method(s) will provide a sufficient level of accuracy for its intended goals. Additional information on selecting a quantification method can be found in Chapter 7 and guidance on which methods may be best suited for different situations is provided in the FLW Quantification Method Ranking Tool. The online *Guidance on FLW Quantification Methods* provides general guidance on 10 common quantification methods. This document and related tool are online at www.flwprotocol.org.

5. Undertake quantification using existing or new data

The following issues should be taken into consideration when preparing a government-level FLW inventory.

- **Sampling and scaling of sectoral data**
  It will generally not be feasible or realistic to quantify all of the FLW being generated at every individual site within a sector. The government or sectors undertaking the quantification may therefore make use of sampling and scaling techniques in order to estimate FLW quantities for the sector as a whole. Additional information on sampling and scaling can be found in Appendix A.

- **Reporting sectoral data**
  Table 13.2 lists the information required to be included in an FLW inventory report. When possible, each sector covered in a government-level inventory should have its own separate sector-level inventory that contains the required information. This will allow for comparisons across time at a sector level to track how the amount of FLW has changed.

- **Coordinating and combining sectoral data**
  Once the government has data available for the individual sectoral inventories, it will need to combine them into one overarching aggregated inventory. At this stage it will be important to check the scopes of the sectoral inventories again, to ensure that they each have identical scopes and therefore can legitimately be combined. If differences among the sectoral inventories do exist, these differences must be clearly reported in the final inventory report. An example of a national study that reported annual food waste generated by households, hospitality and food service, food manufacture, retail and wholesale sectors is *Estimates of Food and Packaging Waste in the UK Grocery Retail and Hospitality Supply Chains (2013)*.

Box 10.2 provides a simplified example of a hypothetical governmental FLW inventory conducted at the city level.

Box 10.2 | Hypothetical Inventory Conducted by a City Agency

The government of a city decides to undertake an FLW quantification study to assess how much FLW is being generated by two separate sectors within the city—the food manufacturing industry and the food retailing industry. The goal is to understand how much FLW goes to landfill and how much to codigestion/anaerobic digestion.

The city's scope is:

Timeframe: 1 calendar year

Material type: Food and associated inedible parts

Destinations: Landfill and codigestion/anaerobic digestion

Boundary: *Food type:* All food, excluding beverages (GSFA 1.0-13.0, 15.0, 16.0); *lifecycle stage:* at the food manufacturing stage (ISIC 1010-1070) and retail of food and beverage stage (ISIC 4721 and 4722); *geography:* within the city limits; *organization*: all owned food manufacturing facilities and all owned grocery stores.

With the scope of the FLW inventory defined, the city government should begin by mapping the food manufacturing sector and the food retail sector. In this example, it identifies a set of companies within each sector that can serve as a representative sample for the sector as a whole and asks them to participate in a quantification study. The city government provides the scope to each participant as well as the quantification method (in this case, a waste composition analysis). By specifying the scope and quantification method, the government is helping to ensure that the FLW inventories produced will be comparable.

The companies conduct their own individual inventories with the government providing technical support where needed. They share the data with the study's researcher, who scales the data up to represent the city as a whole. Once this exercise is complete, the government reports on the inventory results as seen in the table below.

Hypothetical Results of a City-Level FLW Inventory (1,000 kg)

Sector	FLW	Food and Inedible Parts		Food		Inedible Parts	
		Landfill	Codigestion/ Anaerobic Digestion	Landfill	Codigestion/ Anaerobic Digestion	Landfill	Codigestion/ Anaerobic Digestion
Food Manufacturers	2,500	1,300	1,200	900	500	400	700
Food Retailers	1,300	900	400	800	300	100	100
Total	3,800	2,200	1,600	1,700	800	500	800

In this simplified hypothetical example, the city learns from the exercise that food manufacturers generate almost twice as much FLW as food retailers, and that much of the FLW being generated by the food retail sector is going to landfill. This insight may then lead to efforts to see whether FLW in these sectors can be reduced, recovered, or diverted away from landfill toward other destinations.

11. Recording Causes of FLW

Where possible, entities using the *FLW Standard* should record the causes and drivers related to their generation of FLW while conducting an inventory. In this standard, a "cause" is defined as the proximate reason for the occurrence of FLW, while a "driver" is defined as an underlying factor that plays a role in creating the cause.

Recording causes and drivers is not a requirement of the *FLW Standard*, but entities are strongly recommended to do so. The information gathered while recording causes and drivers can help entities identify and understand what is generating their FLW. This information in turn can inform and strengthen the development of FLW prevention and reduction strategies.

For example, a retailer might find that significant quantities of eggs are recorded in its FLW inventory. But, without having gathered information to identify the causes, the retailer will find it more difficult to identify a solution that addresses the reason for the eggs remaining unsold. Likewise, a government body may have collected data from various sectors on where FLW is generated, but without knowing the causes of that FLW it will be difficult to tailor policies and programs to address it.

11.1 Identifying Causes

In some cases, an entity may be able to record only the immediate reason for FLW at the time of quantification, because the underlying driver may not be readily apparent. Therefore, identifying and recording causes should be considered the priority when choosing to report the reason FLW was generated. In some cases, multiple causes will be applicable to the same FLW, in which case all applicable causes should be recorded. Table 11.1 provides a non-exhaustive list of possible causes of FLW from which an entity could choose.

11.2 Identifying Drivers

Drivers will often be determined by the operating context of the entity conducting an inventory. For example, if a farmer discovers that her tomatoes are consistently being rejected at market, she may identify overly stringent cosmetic standards as the driver. If a restaurant learns while recording FLW that a certain item in a buffet is frequently left over at the end of the day, the driver could be a mismatch between the restaurant's understanding of consumer demand for that item and actual demand. If a government sees that significant amounts of meat are ending up in landfills due to spoilage, the government may then identify the lack of refrigeration and other cold-chain technology throughout the country as the driver.

Table 11.1 | Causes of FLW, by Stage in the Food Supply Chain (Not Exhaustive)

PRODUCTION	HANDLING AND STORAGE	PROCESSING	DISTRIBUTION AND MARKET	CONSUMPTION
▸ Spillage ▸ Cosmetic damage ▸ Damage from pests or animals ▸ Not harvested	▸ Spillage ▸ Cosmetic damage ▸ Damage from pests or animals ▸ Rejected from market ▸ Unable to reach market ▸ Unable to sell due to quality or size ▸ Spoilage	▸ Spillage ▸ Trimming during processing ▸ Rejected from market	▸ Product recall ▸ Cooked improperly ▸ Food cooked but not eaten ▸ Cosmetic damage ▸ Spoilage ▸ Past use/sell-by date	▸ Product recall ▸ Cooked improperly ▸ Food cooked but not eaten ▸ Cosmetic damage ▸ Spoilage ▸ Past use/sell-by date

Table 11.2 provides a non-exhaustive list of drivers by stage in the food supply chain that may lead to the causes of FLW listed in Table 11.1.

The driver may be less apparent to entities than the immediate cause, and not all entities will be able to attribute drivers to the FLW contained in their inventories. However, entities that are able to identify and record drivers will be more prepared to design FLW prevention and reduction strategies.

Table 11.2 | Drivers of FLW Causes, by Stage in the Food Supply Chain (Not Exhaustive)

PRODUCTION	HANDLING AND STORAGE	PROCESSING	DISTRIBUTION AND MARKET	CONSUMPTION
▸ Premature or delayed harvesting ▸ Poor harvesting technique ▸ Lack of access to market or processing facilities ▸ Poor access to pesticides, inadequate fencing ▸ Price volatility resulting in commodity price too low to cover harvest cost ▸ Product specifications (e.g. size, cosmetic standards)	▸ Improper drying of grains leading to fungal infection ▸ Inappropriate choice of storage containers ▸ Lack of storage facilities, including lack of cold storage ▸ Rough handling of products during loading and unloading ▸ Poor conditions during transport ▸ Delays at docks or national borders for inspection	▸ Contamination on the processing line ▸ Errors in processing resulting in defects ▸ Improper packaging ▸ Product specifications (e.g. size, cosmetic standards)	▸ Regular replenishment of stocks, leading consumers to select most recent products ▸ Food prepared but not served ▸ Portion/package sizes too large ▸ Failure in demand forecasting ▸ Lack of system for food donation	▸ Large pack sizes containing more than the consumer uses ▸ Inadequate planning before shopping ▸ Confusion over date labels on packaging ▸ Lack of cooking knowledge ▸ Inadequate storage ▸ Sub-optimal storage of food

Source: Adapted from FAO (2014)

11.3 How to Record and Report Causes and Drivers

When reporting on causes, an entity should match causes and drivers to each type and amount of FLW in the inventory. Table 11.3 provides an illustrative example of how a produce packing house might record the causes and drivers of several forms of FLW in its inventory. As one example from the table, the packing house notes that it was a minimum-size product specification that led to the rejection of 500 kg of apples from the market—the apples were too small to sell. This level of detail increases the ability of the entity to identify strategies for preventing or reducing that FLW in the future, for example, selling undersized apples at a reduced price.

Entities should provide as much information as possible in their inventory report. When a specific cause or driver is unknown, the reporting entity should note that within the report.

Further guidance on reporting can be found in Chapter 13.

Table 11.3 | Illustrative Example of Reporting on Causes and Drivers in an Inventory

FLW TYPE	AMOUNT (KG)	CAUSE	DRIVER
Tomatoes (CPC subclass 01234)	1,000	Cosmetic damage	Poor conditions during transport
Tomatoes (CPC subclass 01234)	3,000	Spoilage	Lack of cold storage facilities
Apples (CPC subclass 01341)	500	Rejected from market	Product specification (minimum size)
Corn (CPC class 0112)	2,000	Not harvested	Unknown

12. Review and Assurance

REQUIREMENT

If assurance of the FLW inventory is undertaken (may include peer review, verification, validation, quality assurance, quality control, and audit), create an assurance statement

Assurance may include peer review, verification, validation, quality assurance, quality control, and audit. Assurance can help to ensure that FLW estimates are accurate, consistent with the *FLW Standard*, transparent, relevant, and without material misstatements. An assurance process can be conducted either by the reporting entity or by an external third party. An assurance process generally takes place before reporting occurs.

While assurance processes are not a requirement of the *FLW Standard*, obtaining assurance of quantifications obtained using the standard can provide a variety of benefits for reporting entities, including:

- increased confidence in the reported information that will form the basis of prevention targets, FLW reduction strategies, and related decisions;
- improved internal accounting and reporting practices (e.g., methodological documentation, data collection, calculation); and
- greater stakeholder confidence in the reported information.

Careful and comprehensive documentation of inventory methodology and calculations is a vital step in preparing for assurance. If an entity chooses to undertake assurance, it **shall** prepare an assurance statement that includes:

- whether the assurance was prepared in-house (first-party) or by a third party;
- the assurance opinion;
- a summary of the assurance process;
- the relevant competencies of the assurance providers; and
- an explanation of any potential conflicts of interest.

12.1 Key Terms in Assurance

In the assurance field, different terms are used to describe various assurance processes (e.g., verification, validation, quality assurance, quality control, audit). Though not comprehensive, Table 12.1 summarizes some of the terms that reporting companies may encounter.

Table 12.1 | Key Terms Used in Assurance

ASSURANCE TERM	DESCRIPTION
Assertion	A statement by the reporting entity on the FLW estimates. The assertion is presented to the assurer
Subject matter	FLW estimates and supporting information included in the inventory report. The type of assurance performed will determine which subject matter(s) should be assessed
Assurance criteria	The benchmarks used to evaluate or measure the subject matter. Criteria include the standard's requirements, methodological choices, data quality and uncertainty, and others determined to be suitable by the reporting organization and assurer for public reporting
Evidence	Data sources and documentation used to estimate FLW and support the subject matter of the reporting entity's assertion. Evidence should be sufficient in quantity and appropriate in quality
Assurance standards	Standards, used by assurers, which set requirements on how the assurance process is performed
Assurance statement	The results of the assurer's assessment of the reporting organization's assertion. In the event that the assurer determines that a conclusion cannot be expressed, the statement should cite the reason

12.2 The Assurance Process

RELATIONSHIPS OF PARTIES IN THE ASSURANCE PROCESS

Three parties are involved in the assurance process: the entity seeking assurance, stakeholders using the FLW inventories, and the assurer(s).

When the reporting entity performs its own assurance, this is known as first-party assurance. When a party other than the reporting entity performs the assurance, this is known as third-party assurance (Table 12.2).

Entities should choose assurers that are independent of, and have no conflicts of interest with, the FLW inventory and its reporting process.

For external stakeholders, third-party assurance is likely to increase the credibility of the FLW inventory. However, first-party assurance can also provide confidence in the reliability of the inventory, and it can be a worthwhile learning experience for an entity prior to commissioning third-party assurance.

Inherently, assurance provided by a third party offers a higher degree of objectivity and independence. Typical threats to independence may include financial and other conflicts of interest between the reporting organization and the assurer. These threats should be assessed at the start of the assurance process. Companies receiving first-party assurance should report how potential conflicts of interest were avoided during the assurance process.

COMPETENCIES OF ASSURERS

A competent FLW inventory assurer has the following characteristics:

- assurance expertise and experience using assurance frameworks;
- knowledge and experience in conducting FLW inventories and/or associated methodologies;
- ability to assess the magnitude of potential errors, omissions, and misrepresentations; and
- credibility, independence, and professional skepticism to challenge data and information.

Table 12.2 | Types of Assurance

TYPE OF ASSURANCE	DESCRIPTION	INDEPENDENCE MECHANISM
First-party assurance	Person(s) from within the reporting entity, but independent of the FLW inventory, conducts internal assurance	Different lines of reporting (i.e., assurer does not report to those involved in conducting or reporting the FLW inventory, and vice versa)
Third-party assurance	Person(s) from an organization independent of the entity conducting the FLW inventory conducts third-party assurance	Assurer and the reporting entity are not part of the same organization

PERFORMING ASSURANCE

Assurance engagements, whether performed by a first or third party, involve a number of steps, including:

- planning and scoping (e.g., determining risks and material misstatements);
- understanding the methodology of the inventory, the data sources used, and the calculations (including assumptions);
- performing the assurance process (e.g., gathering evidence, performing analytics);
- evaluating the results; and
- determining and reporting the conclusions.

The nature and extent of assurance processes can vary depending on whether the assurance engagement is designed to obtain reasonable or limited assurance. The highest level of assurance that can be provided is reasonable assurance. (Absolute assurance is never provided because there are always uncertainties in measurement.) The process of obtaining assurance evidence is less rigorous in limited assurance than in reasonable assurance.

TIMING OF THE ASSURANCE PROCESS

The assurance process is conducted before the public release of FLW estimates by the reporting entity. This allows for material misstatements to be corrected prior to the release of the assurance opinion (or revised opinion) and assertion. The assurance process should be initiated far enough in advance of the release of FLW estimates that the assurance work is useful in improving the FLW estimates when applicable.

> *Assurance can help to ensure that FLW estimates are accurate, consistent with the* FLW Standard, *transparent, relevant, and without material misstatements.*

The reporting entity may wish to consider starting the assurance process when the planned methodology has been developed, so that any changes suggested by the assurer can be incorporated before fieldwork is undertaken. This approach has benefits over assurance processes that start at the reporting stage; issues with quantification methodologies that do not get picked up until the reporting stage can rarely be addressed after the quantification is complete. An assurance of the methodology also compels those undertaking the inventory to consider all aspects of the methodology and their effect on the results at an early stage.

The methods and the reasons for their selection should be documented in preparing for this early stage of assurance; the act of documentation can uncover aspects of the methodology that need strengthening. Because the assurer should have expertise in relevant quantification methods, its experience can help strengthen the methods to be used, benefiting the inventory and the robustness of the final results.

The time period required for assurance is dependent on the nature and complexity of the subject matter and the level of assurance sought.

PREPARING FOR ASSURANCE

Preparing for assurance is a matter of ensuring that the evidence required by the assurer is available or easily accessed. The type of evidence and documentation requested by the assurer will depend on the subject matter, the sector, and the type of assurance being sought.

Prior to starting the assurance process, the reporting organization should ensure that the following documentation is prepared and available to the assurer:

- the company's written assertion (e.g., FLW estimates and report);
- the complete methodology;
- sufficient and appropriate evidence, when available (e.g., raw data, analytical calculations).

If the assurance process is being performed concurrently with the quantification, some of these items may not be available at the outset. In this case, the reporting organization should offer the necessary documentation as it becomes available.

> *Entities should choose assurers that are independent of, and have no conflicts of interest with, the FLW inventory and its reporting process.*

ASSURANCE CHALLENGES

There are several challenges in assuring FLW estimates. Estimates may rely on a mixture of collected data, existing data, calculations, and assumptions. There will be a degree of uncertainty in all estimates, including biases that are difficult to quantify. Therefore, when performing assurance, it is important to consider the methods used for data collection, the integrity of the existing data used, and the appropriateness of assumptions used.

ASSURANCE STATEMENT

The assurance statement conveys the assurer's conclusion about the FLW inventory results. It may take different forms depending on whether the assurance was performed by a first or third party. The following outlines what may be included in the statement. It combines the required contents of an assurance statement with other information that the standard recommends an entity includes, when applicable:

Introduction

- A description of the reporting entity
- A reference to the reporting entity's assertion

Description of Assurance Process

- The relevant competencies of the assurers (required)
- A summary of the assurance process and work performed (required)
- Description of the reporting organization's and assurer's responsibilities
- List of the assurance criteria
- Whether the assurance was performed by a first or third party (required)
- If first party, how any potential conflicts of interest were avoided (required)
- The assurance standard (see Table 12.1) used to perform assurance

Conclusion

- Assurance opinion, including level of assurance achieved (limited or reasonable)
- Any additional details regarding the assurer's conclusion, including details regarding any exceptions noted or issues encountered in performing the assurance

When there are material departures in the assertion from the assurance criteria, the reporting entity should report the implications of the departures. Entities may choose to report any recommendations from the assurer regarding improvements that should be made to future updates of the entity's FLW estimates.

13. Reporting

Reporting is crucial to ensure accountability and effective engagement with stakeholders—both external and internal. It is essential that the reported information is based on the key accounting principles of relevance, accuracy, completeness, consistency, and transparency (described in Chapter 5). A sample inventory reporting template is available at www.flwprotocol.org.

Based on the accounting and reporting requirements already described in other chapters, this chapter summarizes the information that shall be reported in order for an FLW inventory report to be in conformance with the *FLW Standard*. In addition to required information, an entity should consider reporting on other elements that meet its specific goals or the needs of its potential audience. These recommended elements are optional and noted in Section 13.3. They may be added to the inventory report or made available upon request.

The following sections provide guidance on:

- The objectives of reporting
- The potential range of audiences for an FLW report
- Communicating the results of a report
- Describing limitations
- Reporting on the requirements of the *FLW Standard*
- Optional reporting elements

13.1 Guidance on Reporting

OBJECTIVES OF REPORTING

The overarching objective of producing an FLW inventory in conformance with the *FLW Standard* is to create positive incentives to pursue FLW reductions within and across food supply chains. Specifying the goals for quantifying FLW is the first step to achieving this objective and reporting is the final step. The full process, from developing the inventory to reporting the results, is designed to help improve understanding of the opportunities to prevent and reduce FLW. Reporting also helps facilitate communication with internal and external stakeholders, which in turn helps entities to prioritize sources of FLW and address them.

POTENTIAL AUDIENCES

As entities set goals and develop an FLW inventory, it is important to keep in mind the needs of the audience who will use the inventory report. The audience of potential users is varied and includes the parties who initially set the goals that triggered the reporting entity to develop an FLW inventory (e.g., corporate management, industry association, government agency). Table 13.1 describes some of the possible audiences but it is not intended to be a comprehensive list.

COMMUNICATING RESULTS

Regardless of the audience, the report should be designed to clearly describe the goals of the FLW quantification, and the context and rationale for various accounting decisions; summarize the overall conclusions that can be drawn from the inventory; and describe the limitations of the inventory results. The audience for an FLW inventory report is likely to be interested in information about quantities of FLW, but will probably also be interested in what the entity is doing, or plans to do, or reduce FLW as a result of the inventory. Therefore, in preparing an FLW report, an entity may also choose to inform its stakeholders of the actions it plans to implement and, where appropriate, the opportunity for particular stakeholders (e.g., consumers or policymakers) to take steps to reduce FLW.

Table 13.1 | Potential Audiences for an FLW Inventory Report and their Interests

TYPE OF AUDIENCE	NATURE OF INTEREST IN FLW INVENTORY REPORT (ILLUSTRATIVE)
Intergovernmental agencies	May have FLW targets or goals that an entity seeks to report against, e.g., the UN Sustainable Development Goal Target 12.3[a]
Policymakers and government program administrators	May use the inventory results to plan future programs and policies, such as voluntary or mandatory programs on FLW reduction
Sustainability reporting programs	May provide a platform to report, register, and disseminate inventory results
FLW practitioners (e.g., researchers, academics)	May wish to use the inventory results as data inputs to another study
Sustainability/environmental practitioners	May seek to understand more about FLW in a country, sector, or food category
Assurance providers	May perform assurance on the inventory
General public	May have an interest in FLW but no understanding of or prior experience with FLW inventories

[a] The Sustainable Development Goals (SDGs) define aspirational global targets with each government setting its own national targets, guided by the global level of ambition but taking into account national circumstances. Goal 12 of the SDGs is to: "Ensure sustainable consumption and production patterns." An accompanying target (Target 12.3) is: "by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses." https://sustainabledevelopment.un.org/sdg12

Once an entity has published its first FLW report, subsequent reports should provide an overview of any changes that have occurred since the previous report and highlight efforts to address FLW. Examples could include a summary of reductions or increases in amounts of FLW relative to the previous inventory, an explanation of why FLW has increased or decreased, highlights of the most effective initiatives, and plans to focus reduction efforts on a few key FLW hotspots.

DESCRIBING LIMITATIONS OF INVENTORY RESULTS

It is important that audiences are aware of the inventory's scope and other factors that affect the results and limit the inventory's uses; an entity should therefore include a relevant "disclaimer." This is a short paragraph, which lays out considerations that should be taken into account when evaluating and using results provided in the FLW inventory report. It helps communicate to audiences the limitations that may affect the comparability and accuracy of the results (Box 13.1).

Box 13.1 | Sample Text for Describing Limitations

The results presented in this report are unique to the assumptions and practices of Entity X. Readers of this report should use caution when drawing conclusions based on a comparison of these results with those of any other FLW inventory. The comparability and accuracy of inventory results is affected by an inventory's scope (i.e., timeframe, material type, destinations, and boundary as defined in the *Food Loss and Waste Accounting and Reporting Standard*), quantification methods, and assumptions. Readers may refer to the *Food Loss and Waste Accounting and Reporting Standard* (www.flwprotocol.org) for a glossary of terms and additional insight into the FLW inventory process.

13.2 Required Information

Table 13.2 provides a summary of the elements to include when reporting on FLW in conformance with the requirements of the *FLW Standard*. A sample reporting template based on this table is provided at www.flwprotocol.org; users of the standard may, however, report the results in whatever format is deemed to be most useful to the intended audience, provided that all the required information is reported. In the case of requirements where a user is directed to "describe" information, users of the *FLW Standard* should convey sufficient detail to meet the needs of the intended user of the FLW inventory.

13.3 Optional Reporting

In addition to required information, an entity should consider reporting on other elements that meet its specific goals or the needs of its potential audience. These recommended elements may be added to the inventory report or made available upon request and include the following:

Scope/Methodological details

- Additional background information on inventory results and how they are calculated
- Additional disaggregation of results. Examples include amount of FLW by:
  - food category (e.g., by food type such as meats, grains, fruits, and vegetables)
  - lifecycle stage
  - geography
  - organizational unit(s)
- For relevant destinations, information about whether the FLW is valorized, proportion of FLW valorized, and what resources are recovered (see Section 6.5)
- Efforts to reduce uncertainty (see Chapter 9)
- When normalization factors have been applied, include a description of the factors chosen and the rationale for their selection along with the source of normalization data (see Appendix C)

Uses of the FLW inventory report

- Limitations concerning the proper use of results (see Box 13.1)
- Additional guidance on how the results should be interpreted and used

Causes and drivers of FLW

- Qualitative data gathered through the FLW quantification study concerning the causes of FLW (see Chapter 11)

Setting targets and tracking changes

- Reason for choosing base year
- Detailed FLW reduction plans
- A summary and explanation of any change in FLW since the previous inventory
- Uncertainties associated with the results
- Base year recalculation policy and the basis and context for any recalculations
- Approach used for monitoring target
- FLW at all points where quantified within the target timeframe (includes total quantity and metric(s) used to assess the target, e.g. FLW per inhabitant)

Table 13.2 | Summary of Items to Include in Reporting Required Information in an FLW Inventory

REPORTING CATEGORY	ELEMENTS	REQUIRED ADDITIONAL DETAIL, WHERE APPLICABLE
General Information	▶ Name of entity about which information is being reported ▶ Contact information ▶ The unit of quantification (expressed as weight) ▶ Date inventory prepared ▶ For subsequent inventories, a link to previous inventory reports and description of any methodological changes	
Scope (see Chapter 6)	Timeframe (including starting and ending date)	
	Material type (food, associated inedible parts, or both)	If food or associated inedible parts removed from the food supply chain are accounted for separately: ▶ Sources or frameworks used to categorize a material as food or as inedible parts (including assumptions used to define whether or not material was "intended" for human consumption) ▶ Approach used to calculate the separate amounts and, if applicable, all conversion factors used and their sources
	Destination(s) and path(s) (paths only required if destination is unknown)	
	Boundary, namely food category(ies), lifecycle stage(s), geography, organization (including source of classification used)	
	Confirmation of the following: Exclusion of packaging and any other non-FLW material (and its weight); reported weight of FLW reflecting the state in which it was generated, that is, before water was added or before the intrinsic water weight of FLW was reduced; exclusion of pre-harvest losses	Describe approaches used if calculations were needed to separate the weight of FLW from non-FLW materials, or to estimate the original weight of FLW
Inventory Results	Total amount of FLW (weight)	The amount broken down by: ▶ Material type (total of "food and associated inedible parts," or separately by material type) ▶ Destination (if known) or total FLW by path, if destination unknown

Table 13.2 | Summary of Items to Include in Reporting Required Information in an FLW Inventory (continued)

REPORTING CATEGORY	ELEMENTS	REQUIRED ADDITIONAL DETAIL, WHERE APPLICABLE
Deciding how to quantify FLW (see Chapter 7)	Describe the quantification method(s) used. If existing studies or data are used, identify the source and scope	
Data collection, calculation, and analysis (see Chapter 8)	If sampling and scaling of data are undertaken, describe the approach and calculations used as well as the period of time over which sample data are collected (including starting and ending dates)	
Assessing uncertainty (see Chapter 9)	Provide a qualitative description and/or quantitative assessment of the uncertainty around FLW inventory results	
If assurance is undertaken (see Chapter 12)	Create an assurance statement including: ▶ Whether the assurance was first or third party ▶ The assurance opinion ▶ A summary of the assurance process ▶ The relevant competencies of the assurance providers ▶ An explanation of any potential conflicts of interest	
If the amount of FLW is tracked over time and a reduction target set (see Chapter 14)	▶ Base year ▶ Scope of the target (where relevant, include reduction target and completion date) and whether all or only some of the FLW inventory results will be tracked over time. If only some of the inventory results are being tracked, explain why ▶ Recalculation of the base FLW inventory when significant changes in the quantification method or assumptions occur	

14. Setting Targets and Tracking Changes over Time

REQUIREMENT

If tracking the amount of FLW and/or setting an FLW reduction target, select a base year, identify the scope of the target, and recalculate the base year FLW inventory when necessary

FLW accounting and reporting allows entities to track and report FLW over time. Entities may set reduction targets for their own future FLW, in line with the goals they have established for quantifying FLW. Alternatively, an external actor (e.g. an intergovernmental agency, national government, or industry organization) may set a target for constituent entities.

An entity can report an FLW inventory in conformance with the *FLW Standard* without setting a reduction target and tracking inventory changes. However, entities that do set reduction targets and track inventory changes **shall** follow the requirements included in this chapter. The following sections focus on:

- Selecting a base year
- Identifying the scope of a target
- Choosing a target
- Monitoring performance against a target
- Recalculating base year FLW

14.1 Selecting a Base Year

The time period, usually a year, against which an entity's FLW is tracked over time, is often referred to as a "base year." The amount of FLW generated in the base year can be compared with the amount generated at the end of the target period to determine whether or not the target has been achieved.

Users of the *FLW Standard* **shall** select a base year against which to set targets and track performance over time. Users should also specify the reasons for choosing that particular base year. An entity will derive the most benefit from selecting a base year where FLW has a high degree of accuracy (i.e., a low level of uncertainty) because changes tracked over time will then be more meaningful and consistent. An entity might therefore decide not to select a base year until it has FLW inventory results that provide a good representation of its actual FLW.

14.2 Identifying the Scope of the Target

Users of the *FLW Standard* **shall** specify the scope of the target, in particular stating whether all or only part of FLW inventory results will be tracked over time. If an entity decides to include only part of its inventory data in the scope of the target, it **shall** explain why.

The scope of the inventory that is defined as the base year FLW must be set in accordance with the requirements and guidance provided in Chapter 6. This scope should then be kept constant between years when setting and tracking targets.

Ideally, the scopes established for an FLW inventory and for a target will be identical; however, instances may occur where an entity sets a target that does not align exactly with its inventory. This is more likely to occur when a target is defined more narrowly than the FLW inventory. Table 14.1 provides an example of how to differentiate between the scope of an FLW inventory and the scope of a target. In this example, a pineapple canning company has set the following target: "Reduce the amount of food [i.e., flesh from pineapples] that is going to landfill by 25 percent by 2035." In such cases, an entity should report any differences between the scopes of the inventory and the target.

14.3 Choosing a Target

Once a base year is established, an entity can set a target for FLW reduction over time. Entities are not required by the *FLW Standard* to set a reduction target, but should consider setting a target in the context of their overall goals. Targets can raise awareness, stimulate focused attention, and mobilize resources toward reducing FLW. Entities should consider several factors when setting an FLW reduction target: target type, completion date, and level.

TARGET TYPE

Entities can set absolute targets, relative targets (also called intensity targets), or a combination of absolute and relative targets. An absolute target is expressed as a specific amount. An example would be that a company intends to reduce FLW by 1 million metric tons from 2016 levels by 2020. A relative target is expressed in comparison to another metric. An example would be that a national government sets a target of reducing FLW by 50 percent *per capita* from 2016 levels by 2030. To ensure transparency, an entity using a relative target should also report the absolute amounts of FLW covered by the target's scope.

A relative target could also compare the amount of FLW relative to all food within the scope of the target (e.g., a country produces FLW equal to 20 percent of its food supply, or 40 percent of the salad sold by a restaurant becomes FLW). In such cases, an entity would need to be able to quantify the entire amount of food within the scope.

TARGET COMPLETION DATE

The target completion date indicates whether the target is relatively short or long term. The date should be expressed in the same unit of time as the base year (e.g., a calendar year or 12-month period). An entity should set long-term targets (e.g., a target period of ten years or more) to guide long-term planning. Short-term targets, or milestones within a long-term target, allow an entity to measure progress more frequently. The selection of long-term or short-term targets will also be influenced by the frequency with which an entity undertakes FLW monitoring.

Table 14.1 | Illustration of Difference between the Scopes of an FLW Inventory and an FLW Reduction Target: Pineapple Canning Company

COMPONENT OF FLW INVENTORY SCOPE	FLW INVENTORY	FLW TARGET
Timeframe	One year (2016)	One year (2035)
Material type	Food and associated inedible parts	Just food
Destination	All destinations	Landfill only
Boundary	Pineapples in all canning facilities directly operated by the company in Honduras	Pineapples in all canning facilities directly operated by the company in Honduras

TARGET LEVEL

The level at which a reduction target is set represents a level of ambition. When a target is set internally, that is, by the reporting entity itself, the target will reflect the level of the entity's ambition. When a target is set by an external actor, such as a national government or an industry association, an entity should either use that target or strive to be more ambitious. In general, an entity should set a target that will result in a significant reduction of FLW relative to the established base year. Additionally, targets can and should be made more ambitious over time as progress in FLW reduction occurs and new technologies and interventions for reducing FLW become available.

14.4 Monitoring Performance Against Targets

There are a number of different ways to monitor and evaluate performance against targets. Monitoring involves the quantification of FLW at various time intervals over the course of the target timeframe; it allows an entity to see whether or not it has achieved (or is on a pathway to achieving) a target. Eval ation is the process of assessing whether efforts to reduce FLW are effective; it provides a deeper understanding of which initiatives or activities were successful in achieving (or driving progress toward) a target.

DEVELOPING AN FLW MONITORING PLAN

It is advisable for an entity to develop a plan for monitoring at the beginning of the target time period, ideally while the details of the target are being decided because the practicalities of monitoring may affect how the target is framed. When reporting on progress, the entity should describe the approach used for monitoring. The following sections describe a series of considerations important to monitoring: quantification frequency, consistency of scope, and consistency of quantification method.

QUANTIFICATION FREQUENCY

The monitoring plan should include the frequency with which FLW will be quantified. At a minimum, FLW should be monitored at the start and end point of the target period. Interim points of quantification during the course of the target period may also be undertaken to give an early indication of whether progress toward the target is on track. Entities should plan to undertake interim quantifications at regular intervals, which will provide useful information on the success rates of current FLW reduction strategies and allow for adjustments to be made accordingly. For example, in the UK, local authorities (municipalities) collect household waste and quantify household FLW data using existing waste composition data. Local authorities perform their waste composition analyses at irregular intervals, and the data are combined into a national estimate about once every two years.

FLW accounting and reporting allows entities to track and report FLW over time.

Two years has proven to be a suitable monitoring frequency because it yields sufficient data to produce a reasonably accurate estimate. Performing more frequent estimates would mean:

- basing the estimate on a small number of waste composition analyses, thereby increasing uncertainty to an unacceptable level; or
- using data from a waste composition analysis that had already been used as part of a previous estimate, a practice that should be avoided when monitoring performance against targets.

ENSURING CONSISTENCY OF SCOPE AND REDUCING UNCERTAINTY

In order for an entity to successfully monitor an FLW target, it should ensure that the scope of the FLW inventory being quantified and compared over time remains the same. It is also important that, when possible, an entity uses data with a level of uncertainty that is sufficiently low to detect small changes toward (or away from) the target. This can be achieved by:

- choosing a quantification method that provides a high degree of accuracy. For example, weighing FLW is likely to be more accurate than asking people to recall the amount of FLW through a questionnaire or interview;
- using a robust sampling approach to minimize uncertainties associated with sampling (Section 8.1); and/or
- reducing other uncertainties (and biases) as outlined in Chapter 9.

ENSURING CONSISTENCY OF QUANTIFICATION METHOD

It is also important to be consistent in applying the same or similar quantification methods at the points in time when FLW is monitored. An entity should consider whether information required for the chosen method will be available at each point in time when FLW will be quantified. For instance, if the quantification is based on records from a waste management company, then these records will need to be available for the base year and for the target year.

Changes to the quantification method—both large and small—can have a large influence on the estimate of FLW. In these instances, any methodological changes should be clearly stated in the inventory and highlighted as a possible cause of a change in FLW levels.

14.5 Recalculating Base Year FLW

Users of the *FLW Standard* **shall** recalculate the base year FLW inventory when significant changes occur. Recalculation is necessary to maintain consistency, enable meaningful comparisons of the inventory over time, and accurately monitor progress relative to a target. Significant changes necessitating a recalculation may include:

- structural changes to the organization, such as mergers, acquisitions, and divestments;
- changes to the scope of the inventory;
- changes in calculation methodologies, improvements in data accuracy, or discovery of significant errors;
- changes in government jurisdictional boundaries or borders; and/or
- changes in conversion factors that do not represent changes in underlying FLW.

Significant changes can result not only from single large changes, but also from several small changes that are cumulatively significant. As an alternative to recalculating base year FLW in the event of a major structural change, entities may also re-establish the base year as a more recent year if this is not in conflict with their FLW reduction goals or targets.

ESTABLISHING A BASE YEAR RECALCULATION POLICY

When setting a base year, entities should develop a base year recalculation policy and clearly state the basis and context for any recalculations. Whether or not the base year inventory is recalculated depends on the significance of the changes in inventory scope or methodology. The significance threshold should be defined by the entity and applied consistently. An example of a significant change could be a scope or methodology change that alters the amount of FLW reported by 10 percent or more. As part of the base year FLW recalculation policy, entities should establish and disclose the significance threshold that triggers base year FLW recalculations.

RECALCULATIONS FOR STRUCTURAL CHANGES IN OWNERSHIP OR CONTROL

Entities should retroactively recalculate the base year FLW inventory when significant structural changes occur in the reporting entity, such as mergers, acquisitions, divestments, or changes in national borders. For example, if a company using the standard were to divest a subsidiary in its third year of reporting, the company should recalculate its base year FLW inventory by removing the FLW generated by that subsidiary from the company's base year inventory. This adjustment shows that the apparent reduction in FLW in the third year is the result of a structural change rather than a change in FLW management practices.

In an instance where a company makes an acquisition of a subsidiary with no past FLW inventory available, the company should note this as a reason for a large increase in FLW in reports. The entity could also make efforts to extrapolate from similar organizations in order to get a rough estimate of the amount of FLW the new acquisition may have generated during previous years. In these cases, the FLW of the new subsidiary organization could also be quantified separately so that it does not affect the existing inventory.

RECALCULATIONS FOR CHANGES TO THE SCOPE OF THE INVENTORY OVER TIME

Entities may make changes to the scope of the FLW inventory over time. For example, a provincial government might start by quantifying FLW in just one city in the base year and add additional cities in subsequent years. Or a farmer might quantify FLW related to millet in the base year, but then add sorghum in a subsequent year. If the cumulative effect of adding or changing the scope of the FLW inventory is significant, the entity should include the new items in the base year inventory by back-casting data for the base year based on available historical activity data. When these data are not available, the entity should disclose all changes to the scope that occur after the base year.

RECALCULATIONS FOR CHANGES IN QUANTIFICATION METHODOLOGY OR IMPROVEMENTS IN DATA ACCURACY OVER TIME

An entity might quantify FLW differently over time. For example, an entity might significantly improve its data quality by collecting more data from more sources. The entity should ensure that changes in the FLW inventory over time are the result of actual FLW increases or decreases, not changes in methodology. Therefore, if changes in data sources or methodology result in significant differences in the FLW inventory, entities should recalculate the base year FLW inventory applying the new data sources and/or methodology. When these data are not available, the entity should disclose all changes to the data sources and/or methodology that occurred after the base year.

Appendix A. Approaches to Sampling and Scaling Up Data

A1 Introduction

If data are collected from a sample of FLW-producing units, and/or from physical FLW samples, and then scaled up to estimate the total FLW, the *FLW Standard* requires that the approach and calculations used shall be clearly stated when reporting the results.

This appendix provides general guidance on sampling, including considerations relevant to selecting a sampling approach, obtaining a sample that represents FLW production over time, and determining the appropriate sample size. It also provides guidance on approaches for scaling up data, which is required when the sample data do not cover the whole population and/or timeframe of the FLW inventory.

If an entity does not have expertise in sampling or scaling, it should consult a statistician or an experienced researcher for guidance.

A2 Guidance on Sampling

Selecting a representative sample impacts the accuracy of the data. It is therefore important that the sample of FLW-producing units and physical FLW are as representative as possible of all units and all FLW in the population. There are two main approaches to sampling FLW-producing units, which differ in how well the data produced represents all units. The approaches are "probability" and "non-probability" sampling. In probability sampling, all FLW-producing units in the population stand a known and equal chance of being selected, thus produce a random sample that can statistically represent the characteristics of the whole population being studied. In non-probability sampling, the likelihood of any one FLW-producing unit being selected is often not known (e.g., sometimes because the exact size and nature of the population from which the sample will be drawn are not fully understood). Non-probability samples are less reliable indicators of the characteristics of the whole population.

In some situations, data are obtained for only a fraction of the physical FLW generated by an FLW-producing unit (within a given time period) because it is not practical to measure (or approximate) the entire amount of FLW. For instance, because too much FLW is produced in the time period to weigh it all. In these situations, it is important to obtain a sample that is representative of all FLW generated by the FLW-producing unit(s) in the population (see Section A2.2).

A2.1 APPROACHES TO SAMPLING FLW-PRODUCING UNITS

This section provides an overview of approaches to probability sampling and non-probability sampling, beginning with two examples to highlight the difference between these two approaches.

As an example of probability sampling, a retail company may wish to carry out a waste composition analysis at a sample of its stores because it cannot afford to use this method at every store. Because the company knows precisely how many stores it has and can require them to take part, it is able to select them randomly for inclusion in the study, for example, by assigning each a number and then using a random number generator to pick the stores.

By contrast, if a municipality wants to carry out a waste composition analysis at a sample of stores selling food in the city, it may not know precisely how many stores there are and may not have the authority to require them to participate. In this case it would compile a list of all the stores it knows about and randomly select some number of them. But because some of the stores may refuse to participate and must therefore be replaced with other stores—and because some stores may have been omitted from the original count—not all stores stood the same chance of being included thus the sample is not truly random. This is non-probability sampling.

Probability Sampling

Probability sampling or "simple random sampling" of FLW-producing units involves three basic steps.

1. **Develop or obtain a list of all the FLW-producing units (e.g., individual grocery stores) that fall within the scope of the quantification study**. This is known as the sampling frame and all the FLW-producing units in the frame make up the population for the study. An entity that operates as a business will likely have a list of its sites from which to select samples. If an entity needs to gather information from external sources to define its sampling frame, it can choose from a range of options, depending on the sector(s) included in the study and how the FLW-producing unit is defined. The options include business directories, lists of companies paying taxes, and postal databases. Multiple sources of information may need to be combined (with duplicate FLW-producing units removed from the list).

2. **Select FLW-producing units at random from this list**. Random selection is the foundation of probability sampling because it ensures that all units stand an equal chance of selection, which, in turn, ensures that samples are representative. This selection can be performed using proprietary software or random number generators. An alternative approach is to select every n^{th} unit on the list, with the first unit being randomly selected. The question of how many FLW-producing units to select (i.e., the sample size) is discussed in Section A2.4. This list of randomly selected FLW-producing units is known as the sample.

3. **Obtain FLW data from the FLW-producing units within the sample**. It is usually not possible to obtain information from all FLW-producing units in the sample. For instance, some may refuse to take part in the study. However, efforts should be made to collect FLW data from as many of the FLW-producing units in the sample as possible. Missing data from FLW-producing units will contribute to non-response bias, which occurs if those FLW-producing units that provide information have different levels of FLW compared to those that do not provide data. Making as much effort as possible to boost response is critical because a key aspect of probability sampling is that refusals are not replaced in order to boost the sample size. This would be counter to the rule that all units should stand a known and equal chance of selection.

It is good practice to keep a sampling log where details of successful and non-successful contacts are recorded. Where it is not possible to obtain information from an FLW-producing unit, this should be noted, along with the reason.

Several variants of probability sampling build on the steps above for simple random sampling. These variants, especially cluster (or area) sampling and stratified random sampling, may be appropriate in specific circumstances.

Cluster (or area) sampling is appropriate if the FLW-producing units are geographically dispersed and it is practically difficult to collect information from a randomly chosen selection of them. Cluster sampling often involves a two-stage (or multi-stage) process: first randomly choosing geographical areas (e.g., municipalities, whole farms) in which to work and then randomly selecting FLW-producing units from within those areas (e.g., households within municipalities, fields within farms producing the same crop). This sampling approach helps to reduce the cost of quantification if a large number of samples is needed and the costs (e.g., of travel, sorting sites) need to be contained.

Stratified random sampling is appropriate in cases where there are distinct subgroups within the overall population that generate different amounts or types of

FLW. This approach involves "stratifying" the sample—that is, dividing the population into subgroups before sampling and treating each subgroup as a separate population. Appropriate stratification should lead to lower uncertainty in the overall estimate for the population. In addition, stratification might help an entity make inferences about distinct groups within a population, particularly if some groups have very small numbers of units and random sampling would not include enough of them in the study. Examples of stratification include:

- food manufacturing sites stratified by the type of food being processed;
- agricultural land stratified by the type of crop grown; and
- households stratified by the number of occupants.

Non-probability sampling

Where probability sampling is not possible for practical reasons, an entity can use non-probability sampling. The most commonly used form of non-probability sampling is quota sampling, which is widely used in commercial market and social research.

Quota sampling is a non-probability version of stratified random sampling (see above) but rather than selecting samples randomly from subgroups with shared characteristics, the entity can just select a certain number of units (a quota) from each subgroup. This has the advantage that, if an FLW-producing unit cannot be contacted or declines to take part, it can be replaced by another FLW-producing unit with the same characteristics. The lack of random selection, however, may result in a sample that is not representative of the population; quota sampling therefore tends to be used where simple random sampling is not possible (e.g., because a sampling frame cannot be cost-effectively constructed). It is cheaper to administer than random sampling because it reduces time-consuming call-backs (which are expensive) and therefore generates a larger sample size for a fixed price. The choice between probability sampling and quota sampling is normally determined by consideration of some combination of feasibility, cost, and accuracy.

An entity can recruit sampling units to fill a "quota" in several ways. It is important to ensure that the selected approach does not bias the results. For instance, if an entity is recruiting a representative sample of households, it should perform the recruitment at different times of day to ensure that both working households which tend to be empty during the day stand an equal chance of being selected as non-working households where someone is typically at home during the day. Paying careful attention to ensuring unbiased recruitment can overcome the criticism that quota sampling results in unrepresentative samples.

Other forms of non-probability sampling exist but they often result in samples that are not representative of the population being studied, and are therefore not recommended for use with this standard. These other approaches include convenience sampling (in which, for example, only FLW-producing units that are known to the researcher are studied) and snowball sampling (in which FLW-producing units known to the researcher are initially contacted and they then refer the researcher to other FLW-producing units they know).

A2.2 OBTAINING A SAMPLE THAT REPRESENTS FLW PRODUCTION OVER TIME

When a physical sample of the FLW is taken, it should be representative of variables that correlate with the amount of FLW being generated so that it sufficiently reflects how FLW arises. This requires an understanding of the circumstances under which FLW is generated, which is frequently linked to temporal variability (how FLW is generated over time). As an example, if the FLW generated every week is typically of the same amount and the same food categories (e.g., FLW from a restaurant with a standard menu), then it may be appropriate to sample just one or two occurrences every week.

Important temporal effects include variations in the amount of FLW generated:

- during a week (e.g., different amounts generated on weekends compared to weekdays);

- during a year (e.g., FLW generated mainly around harvest time); and
- between years (e.g., differences between El Niño and La Niña years).

For FLW generated throughout the year, seasonality or other temporal effects may affect its composition. Collecting data on the FLW throughout the year will enable variability within a year to be included in a representative manner. There are typically strong seasonal patterns in purchases (and therefore FLW) among different types of food (e.g., a United Kingdom study confirmed soft drinks are purchased more frequently in summer months while soup purchases are associated with winter months).[44]

For FLW generated at just one time of year (e.g., around harvest time for some agricultural products), sampling is required only during that period of time. Using the example of a harvest period, care should be taken to ensure that the time of the sampling is representative of the harvest period rather than representative of the whole year.

Another way of coping with seasonality is to adjust for seasonal effects when scaling up the measurements (see Section A3.3). However, this requires an understanding of what the seasonal effects are and an estimate of their magnitude. Some countries may have data on purchases of food and drink that indicate seasonal trends, which could be extrapolated to apply to FLW.

In addition to seasonality, there may be variation in FLW between years. In the case of agricultural FLW, there may be differences in the amount and type of FLW due to the weather, for example, between El Niño and La Niña years, or due to the level and type of precipitation during key periods of the growing season. As with seasonality, an entity should take this into account in the research design by, for example, sampling over multiple years or adjusting for known effects where there are relevant data.

Once these types of variables have been considered, an entity should draw up a strategy for sampling the FLW. This strategy should cover the number of samples, as well as how and when the FLW will be accessed.

A2.3 APPROACHES FOR TAKING PHYSICAL SAMPLES OF FLW

This section describes considerations related to physically sampling FLW and three common ways to take a sample.

The approach taken to physically sampling the FLW will be driven largely by practical considerations. As noted in the section above, throughout the sampling process it is important to keep in mind the need for the sample to be representative of all FLW produced by the FLW-producing unit. In an ideal world, all occurrences of FLW within the scope of the inventory would be accumulated, covering all possible sources of variability, and a sample taken from the accumulation. For a number of reasons, including lack of storage space, degradation of the FLW, and health and safety considerations, this approach is unlikely. In practice, several samples will need to be taken over time and, if they are large, subsamples taken from them.

Taking a sample may require machinery and space. An entity should consider these requirements when determining which approach to use because lack of one or the other may rule out a particular approach. In addition, an entity needs to be aware that any technique that physically disturbs the FLW, such as mixing, will make it difficult to characterize the types of food in the FLW, which might be necessary, for example, in a study of FLW generated by households or by restaurants.

If the FLW is a single material (e.g., wheat) then a proportion of it can simply be taken as a sample and quantified. If the FLW is known or suspected to be a mixture of materials (e.g., wheat and barley), a representative sample of the mix should be taken.

It is important to think about the make-up of the FLW to ensure that all its components are sampled in proportion to their occurrence. For example, if a container is filled with tomatoes and lettuce, but the lettuce is all at the bottom, then a sample taken from the top will not be representative. Instead the contents should be tipped out, mixed up and a sample taken of the combined materials. Where possible, measuring FLW before it is even placed into the collection container will result in a more accurate estimate.

The three most common ways to take a physical sample are described below. Because these techniques require the FLW to be mixed, they are not well suited to an entity that is seeking to understand the types of food included in the FLW.

1. Coning and quartering

"Coning and quartering" is used to reduce an accumulation of FLW to a manageable quantity by taking a series of samples. The challenge is to ensure that the final sample is fully representative of the original accumulation of FLW.

The process is as follows. The FLW is mixed thoroughly, then piled up into a cone shape (i.e., "coned"). The cone is then flattened and divided in four parts (quarters) and two opposite quarters are taken away. The remaining pile is then mixed and coned and a further one or two quarters taken away. This continues until a manageable amount remains. Decisions on what constitutes a manageable amount will be largely pragmatic, although statistical techniques can be used to determine sample sizes. If mixing has been effective then the sample should be representative of the whole. Depending on the size and nature of the FLW, coning and quartering may require the presence of a vehicular loading shovel and a driver.

2. Compass point sampling

In "compass point sampling," the FLW is mixed up in a pile and small samples taken from four points of the pile (e.g., the "north," "south," "east," and "west"). These smaller samples are combined to create the sample for weighing. When using this approach, it is important to take samples through the whole height of the pile to avoid biasing the sample in favor of the lighter waste that may have risen to the top of the pile. Compass point sampling can be done manually with shovels or using a vehicular loading shovel.

3. Sampling from containers

Where it is known that FLW is evenly distributed within a container, an entity can take a sample directly from the container. This approach is used, for example, to sample grains stored in bags, which is common in developing countries. In that example "spear samplers" (see Figure A1) may be used to take samples from the bags. If the grain is stored in silos, longer spears can be used.

Figure A1 | Example of a "Spear Sampler"

Source: Photo by Pesila Govinden at Natural Resources Institute's Postharvest Loss Reduction Centre

An entity should take several samples, following a sampling regime designed to represent the whole quantity being studied. The samples are then mixed to become a composite sample. If sampling grains, a "riffle divider" (see Figure A2) may then be used to reduce the size of the sample to make it manageable, while ensuring that it remains a representative sample.

Figure A2 | Example of a "Riffle Divider"

Source: Photo by Bruno Tran at Natural Resources Institute's Postharvest Loss Reduction Centre

A2.4 DETERMINING APPROPRIATE SAMPLE SIZE

An entity should consider several factors when selecting the sample size of FLW-producing units, or of the physical FLW, for a study. These include the level of acceptable uncertainty in the results, and the likelihood that some units or physical samples will fail to produce useable data. In most studies, some FLW-producing units from which information is sought will not provide data or may provide different information from that which is being sought. There are statistical techniques an entity can use to determine sample sizes.

Balancing uncertainty and sample size

The sample size selected by an entity should be based on the level of uncertainty it finds acceptable, which will be driven by the nature of the decision being made and how accurate the FLW inventory results therefore need to be. In general, as the sample size increases, uncertainty decreases.

Determining sample size is likely to be an iterative process. An entity should estimate the likely level of uncertainty of key estimates within its FLW quantification before undertaking the study. It may then adjust its sample size accordingly if the predicted level of certainty does not meet its requirements.

To assess likely levels of uncertainty, an entity could draw from previous studies of a similar nature. For example, suppose a prior FLW study found that sampling 200 households led to a 95 percent confidence interval (a measure of uncertainty) of +/- 10 percent, but a new study requires a 95 percent confidence interval at +/- 5 percent or less. To achieve this new confidence interval (i.e., halving the width of the interval associated with the results), the number of units sampled would need to be quadrupled. The sample size for the new study would therefore need to be 800 households. This example shows that improving the accuracy of results can become very expensive. Further guidance on uncertainty is given in Chapter 9 of the main text.

Precise sample size requirements can be calculated using sample size formulas (often referred to as power analysis).[45] To help determine its required sample size, an entity can use prior information about the variation in amounts of FLW between FLW-producing units, for example, as described by the standard deviation or the distribution of measurements. If it does not have access to prior information, it may undertake a pilot study to determine the variation in amounts of FLW, or adjust the sample size as the early results are analyzed. If an entity does not have expertise in sampling, it should consult a statistician or an experienced market or social researcher for more technical guidance.

Accounting for unusable data in a sample

In determining how many FLW-producing units to sample, an entity should take into account a realistic "drop-out rate." For example, if an FLW quantification study requires 100 factories to be included in the ultimate sample (i.e., as FLW-producing units providing robust data), and a total drop-out rate of 25 percent is expected over the course of the study, then the sample should include 133 factories. One way to estimate the drop-out rate is to use data from previous studies.

A3 Guidance on Scaling up Data

A3.1 SCALING DATA COLLECTED FROM A SAMPLE OF FLW-PRODUCING UNITS

One approach for scaling up data collected from a sample of FLW-producing units is to use the *average* amount of FLW per FLW-producing unit (e.g., 70 kilograms FLW per restaurant) and multiply it by the appropriate total of FLW-producing units in the population (e.g., 1,000 restaurants). Using this restaurant example, the total FLW for the population within the inventory is the multiple of these two numbers (i.e., 70,000 kilograms).

Where stratified sampling has been undertaken, an entity would scale up the data for each stratum first before summing it to obtain a total for the whole population. For instance, if a hypothetical population contained two types of business (e.g., a large food processor with a breakfast cereal and bread business), the average amount of FLW would first be found for each type of business and multiplied by the number of processing sites of each type. These two amounts would then be summed for the total population.

A second approach is to scale up the FLW data using a *normalized* amount of the FLW (e.g., FLW per capita, FLW per turnover, FLW per amount of food sold) as described below (Appendix C provides additional guidance about normalizing data). The advantage of using a normalized amount instead of FLW per FLW-producing unit is that the accuracy of the estimate can be increased. A higher degree of accuracy in the estimated FLW is preferable where targets are being tracked, and enables an entity to make related decisions with a greater degree of certainty.

In order to scale up data using normalized data, an entity first needs to divide the amount of FLW for each FLW-producing unit sampled by a certain normalization factor (e.g., weight of food sold by the FLW-producing unit, number of people in the FLW-producing unit). This would give, for each sampled data point, a normalized expression of FLW, such as FLW per kg of food sold, or FLW per capita. An entity then calculates the average of this normalized FLW data (e.g., average FLW per kg of food sold, average FLW per capita). The average of the normalized data is then multiplied by the total number of units—for the factor selected for normalization (e.g., total weight of food sold, total number of people).

Box A2 provides an example of the calculation an entity might make using these two approaches to scaling up data that are collected from a sample of FLW-producing units.

Where a significant piece of data is missing, an entity may also use normalized data for scaling up the FLW data sampled. For example, a national authority may seek to quantify FLW from all grocery retailers within a country. It therefore attempts to obtain information from all retailers. However, the largest retailer, which accounts for a 25 percent market share, does not provide any data. In this circumstance, the entity can normalize the FLW from each of the other retailers using factors that are closely related to the weight of FLW (e.g., the amount of food each sells, their market share), take an average of this normalized data (e.g., amount of FLW per kg of food sold) and then scale up the data for the total retail market to account for the missing retailer.

How to select the most appropriate normalization factor. In order to identify the most appropriate normalization factor to use, an entity may need to undertake an exploratory analysis in which it applies several normalization factors to the sample data. A good normalization factor will have a strong (possibly causal) relationship with the quantity of FLW and therefore lead to a more accurate estimate of FLW. For example, if the amount of FLW per employee fluctuates less across sites than the amount of FLW per site, the former—FLW per employee—is likely to have a more direct relationship to levels of FLW and would be the more appropriate normalizing unit to use in scaling the sampled data. Appendix C includes more information on selecting normalization factors.

Dealing with outliers. An entity should assess whether there are any outlier data points (i.e., values that are outside what might be considered reasonable) when reviewing the data collected from among the FLW-producing units. This assessment should be performed using the normalized data that will be used for scaling. If an entity finds the data points are erroneous, it may either correct

Box A2 | Illustrative Example of Scaling up Data Collected from a Sample of FLW-Producing Units

Background

FLW data are collected from a sample of three apartment buildings. The population (all the FLW-producing units within the scope of the FLW inventory) is 100 apartment buildings with a total of 50,000 residents. Data collected from the three samples are for one week:

Sample 1 (apartment building 1) = 50 kg of FLW per apartment building (100 residents)
Sample 2 (apartment building 2) = 200 kg of FLW per apartment building (500 residents)
Sample 3 (apartment building 3) = 500 kg of FLW per apartment building (1,000 residents)

Approach 1. Scaling by using average FLW data and the population

Step 1. Calculate the average from the three samples (50+200+500)/3 = 250 kg of FLW per apartment building
Step 2. Scale the data to all 100 apartment buildings (250 kg of FLW x 100 apartment buildings) = 25,000 kg of FLW for all 100 apartment buildings

Approach 2. Scaling by using average of normalized FLW data and total units of the normalization factor

Step 1. Normalize data first per apartment resident (i.e., the normalization factor)
50 kg/100 residents = 0.5 kg/resident
200 kg/500 residents = 0.4 kg/resident
500 kg/1,000 residents = 0.5 kg/resident
Step 2. Average the normalized data (0.5 + 0.4 + 0.5)/3 = 0.47 kg/resident
Step 3. Scale the data to all 100 apartments using the normalization factor of total residents:
(0.47 kg/resident * 50,000 residents) = 23,500 kg of FLW for all 100 apartment buildings

them or exclude them from the analysis. If the data points are *not* erroneous, they should generally be included. If there is doubt about whether to include outlier data points, an entity may find it useful to present results with and without these outliers included to illustrate their effect on the overall estimate of FLW.

A3.2 SCALING DATA COLLECTED FROM A PHYSICAL SAMPLE OF FLW

If a physical sample of FLW has been quantified from the total amount of FLW produced, it requires scaling to obtain an estimate for the total FLW generated by the FLW-producing unit. In this situation, an entity will use multiplication as its scaling approach. As an example, if an entity produces three containers of FLW each week and, through the physical sampling process, has found the weight of one to be 10 metric tons (and there is no systematic variation among the containers), then a simple multiplication by three would provide a total of 30 metric tons per week for that FLW-producing unit.

Where variation is expected, the sampling strategy should have accommodated it, in which case scaling up can be performed within strata (e.g., physical samples taken in different seasons, physical samples taken from different parts of a company's operation).

If the FLW inventory includes more than one FLW-producing unit but data are obtained from only one unit, an entity will need to further sum or scale up the data so that its results cover the full scope of its inventory.

A3.3 SCALING RELATING TO TEMPORAL EFFECTS

The timeframe of the inventory represents the period of time for which FLW is being reported (recommended to be 12 months). However, an entity may sample FLW over a shorter period of time (e.g., one month, several one-week periods) and therefore need to scale up the data to reflect the full timeframe of the inventory.

If the sampling undertaken is representative of the whole inventory timeframe or the temporal effects are not believed to be substantial (see above for guidance on temporal effects and obtaining a representative sample of FLW), then scaling up from the sample to the whole timeframe involves simply calculating the appropriate ratio between the two timeframes and using multiplication. For example, if the sampling period is one month, the total amount of FLW generated in that period should be multiplied by 12 in order to report the amount of FLW over a 12-month timeframe.[46]

If the sampling is not representative of the inventory timeframe and temporal effects are believed to be substantial, then the scaling process should take account of this mismatch in order to avoid bias in the results. There are several ways to make adjustments.

If an entity collects data for only some periods (e.g., data for only some months of the year, data for only some days of the week), it can make an adjustment using proxy data, then scale up the FLW data—assuming that the level of accuracy it seeks in its FLW inventory results will not be compromised by using a proxy. For a farmer, a proxy may be data from previous harvests. For household-level FLW, a proxy may be data from a previous year's purchases of food and drink that indicate seasonal trends. For a food processor, a proxy may be data on monthly production volumes.

If proxy factors are not available, scaling up can be performed assuming a constant rate of FLW generation over time, although this approach further reduces the level of accuracy in the total inventory results.

A3.4 WEIGHTING DATA DURING SCALING

If a sample is not representative of the FLW-producing units and/or timeframe of the inventory, an entity can weight the data during scaling to eliminate bias in the results and improve the accuracy. For example, if an entity gathers data throughout the year and across the days of the week, but they are not representative (e.g., because more than one-twelfth of the sampling was in a given month), then weighting can be applied. Stratification of the sample has a similar effect to weighting (see Section A2.1).

In order to correct for the lack of a representative sample, an entity would use weighting factors to make adjustments. Using such factors ensures that under-sampled FLW-producing units are given greater weight (and vice versa). Weighting data can involve complex calculations. Consequently, if an entity does not have sufficient internal expertise, it should seek technical guidance from a qualified professional.

Appendix B. Separating Material Types: Data Sources for Conversion Factors Applied to Individual Items

B1 Introduction

When an entity quantifies food and associated inedible parts separately, it may apply a conversion factor to individual items in order to calculate the proportion (by weight) that is an inedible part (as discussed in Section 8.2 of the main text). This Appendix provides guidance for an entity that is seeking a third-party source of data for its conversion factor(s). It describes considerations an entity should take into account when selecting a source, along with details about specific sources.

B2 Choosing a Data Source for Conversion Factors

A number of sources provide data that could be used as conversion factors. No one source, however, is applicable to all situations globally. An entity should assess the appropriateness of a data source based on the following factors:

- **Availability of relevant data for FLW being quantified**. Many sets of data are developed for a particular nation and consequently contain information only about foods commonly consumed in that particular country.
- **Categorization of "inedible parts**." The conversion factors an entity chooses should align with how the entity categorizes food versus associated inedible parts for its particular FLW inventory. Therefore, it is important that an entity take into account whether a particular source of data categorizes the same materials as food versus associated inedible parts.
- **Information about the preparation state of an item**. Some of the data that could be used for conversion factors are specific to items in their whole state, before being prepared for consumption (e.g., a whole fish). Other data are based on the state in which the item enters the home (e.g., as a fillet of fish). It is important to ensure that the item to which the conversion factor applies is similar to the item being quantified for the FLW inventory. Differences between the two can lead to biases in the resulting estimates.
- **Underlying methodology**. Information about the methodology used to develop the data that could be used as conversion factors is not always readily available. If there were greater transparency about the methodology used (e.g., the number of items sampled, how representative those samples were of the food item in question), an entity would be able to better assess whether a conversion factor is credible and appropriate for its use.

These considerations inevitably lead to a degree of uncertainty when using conversion factors to estimate the percentage of an item's weight that is considered food versus associated inedible parts. In addition, the proportions may vary based on the variety of plant or breed of animal, as well as differences in the growing or rearing conditions (e.g., weather or the availability of nutrients during the growing season). When conversion factors are used, an entity should cite the factors that contribute to uncertainty for its FLW inventory, as discussed in Section 9.1 of the main text.

B3 General Sources of Data for Conversion Factors

Two resources that list many of the food composition datasets compiled by organizations around the world are the FAO's International Network of Food Data Systems (INFOODS)[47] and the website of the European Food Information Resource (EuroFIR).[48] Most of these datasets are specific to a particular country. None of the datasets, however, were designed expressly for calculating the proportion of an item that is food versus associated inedible parts. Rather, they are typically designed to provide detailed information on the nutritional composition of foods, usually from a particular country. But in order for nutritional information to be given for just the edible part, many of the datasets list the proportion or fraction of an item that is considered inedible (by weight) based on the cultural norms of its particular geographic area of focus. In the datasets, this fraction is often referred to as "waste" or "refuse." These proportions can serve as conversion factors as long as the considerations noted in this Appendix are taken into account. Some of the datasets require payment before they can be viewed. A comprehensive comparison of information available across the datasets has not been undertaken by the FLW Protocol.

Among the datasets, the National Nutrient Database for Standard Reference (NNDSR) of the United States Department of Agriculture (USDA) is one of the few that describes clearly which components of an item it considers "refuse." Moreover, if the refuse is made up of multiple components, it often provides the percentage of each particular component relative to the weight of the whole item. In contrast, many other datasets either give no description of what is included under what they term "edible" and "inedible," or provide only incomplete information.

Figure B1 provides an example for a raw apple using the USDA NNDSR data.[49] The item is classified in the database as "Apple, raw, without skin." The proportion of what the NNDSR labels "refuse" is 23 percent (by weight), which is made up of the core and stem (10 percentage points), and skin (13 percentage points).

Figure B1 | Example Using USDA NNDSR Data

Apple (Raw)

Source: USDA (2015)

The benefit of the USDA's NNDSR data set is that an entity could use the percentages provided to select only those particular components that it has categorized as associated inedible parts. If an entity determined that the skins of apples should not be categorized as inedible material (because they are customarily eaten in the food supply chain relevant to the FLW being quantified), then it would use the percentage for the core and stem only. Thus, the conversion factor for inedible parts would be 10 percent.

Because the level of detail available in the NNDSR dataset makes it possible for an entity to select only the percentages that apply to its particular situation (as Figure B1 illustrates), it could be used by an entity outside the United States that does not have a national dataset as a possible source.[50]

For a number of reasons, the proportions calculated for the same item will vary (Table B1). This variance could be due to differences in the types of items between nations (e.g., the different types of apples commonly sold) or differences in assumptions about food preparation methods. For instance, the proportion of an apple that is measured as "skin" may vary depending on whether it is peeled by a knife or with a peeler. With respect to the data shown in Table B1 for an apple core, different datasets may have used different assumptions about how close to the core an individual eats an apple.

Table B1 | Components as Proportion of Whole Item (by Weight): Example of an Apple from Three Datasets

COMPONENTS OF AN APPLE	COMPONENT AS PERCENT OF WHOLE ITEM (AS PURCHASED)		
	WRAP, THE FOOD WE WASTE[A]	MCCANCE AND WIDDOWSON'S THE COMPOSITION OF FOODS[B]	USDA, NNDSR
Core	20% (excludes stem)	11% (excludes stem)	10% (includes stem)
Skin	17%	13%	13%

[a] WRAP (2008)

[b] Public Health England (2015)

B4 Sector-Specific Sources of Data for Conversion Factors

Several additional resources that provide conversion factors are available for particular sectors.

HOSPITALITY AND FOOD SERVICE

The Book of Yields[51] provides a large amount of information specifically for the food service and hospitality sector. Its primary role is to help cooks and chefs buy the right amount of food. It provides "yield" percentages, which are defined as the amount served or used divided by the amount purchased. *The Book of Yields* makes implicit judgments about what is eaten or not. An entity using percentages from *The Book of Yields* as conversion factors should ensure that what *The Book of Yields* considers "eaten" is aligned with the way in which an entity has categorized food versus associated inedible parts.

While this resource may be useful to the hospitality and food service sector in selecting a conversion factor, it is not always clear which particular components of an item (e.g., the apple skin, core and stem, or only the core and stem) are included or excluded from the yield. This is similar to the challenges with using nutritional datasets. Therefore, calculating conversion factors for food versus associated inedible parts from "yield" information should be done with care. No references or methodological information could be found as to how the information in *The Book of Yields* was derived, so it is difficult to assess the uncertainty associated with different estimates.

FOOD AND DRINK PROCESSING

No public information specific to manufacturing and processing appears to be available. However, it is likely that individual companies have access to, or the ability to calculate, their own conversion factors. The lack of a public dataset for this sector could be linked to the commercial sensitivity of such information. It may also be that this information is difficult to generalize because what an individual company considers to be an inedible part is specific and narrowly defined, based on a particular item. In other words, what is considered an inedible part by one company may be considered food by another. For instance, some companies do not include the pulp of citrus fruit in their fruit juice, and may categorize it as an associated inedible part because it was not intended for human consumption in this food supply chain. For other companies, this pulp is an integral part of the final item and therefore would be categorized as food.

In food and drink processing, there will be many cases where the state of the ingredients and agricultural items entering the processing site are very different from the state of ingredients and items produced for sale. Individual companies may therefore need to develop customized conversion factors for their particular situations.

AGRICULTURE

Many conversion factors for determining the inedible part of agricultural items are available in the methodology of the FAO study "*Global Food Losses and Food Waste—Extent, Causes and Prevention*."[52] They are compiled from a range of primary and secondary sources, all of which are listed in the publication.

The FAO also publishes "refuse" factors on its website from a range of other sources, including the USDA NNDSR data (note: the version used may not be the same as that on the USDA website), *Food Security in Practice* technical guide series from the International Food Policy Research Institute, and the *Food Composition Table for use in Africa*.[53] While these sources provide factors that could be used, one limitation is that none of the FAO sources provide either a description of the actual components considered to be inedible or a more detailed breakdown of what could be multiple components that make up the inedible parts. Some of the original sources cited by FAO likely contain this information and additional research might provide further context.

In the specific case of livestock products, factors for converting the live weight of slaughtered animals to dressed carcass weight are available through organizations that provide agricultural advice and other sources such as FAO's *Technical Conversion Factors for Agricultural Commodities*.[54]

Appendix C. Normalizing Data

C1 Introduction

An entity may choose to normalize FLW data to gain additional insights. Normalization involves dividing the weight of FLW by a certain factor, referred to as a "normalization factor," thereby resulting in FLW per unit of something else, such as number of individuals (e.g., national population), financial figures (e.g., company turnover), or other relevant factor (e.g., amount of food sold). Normalizing the data generates a metric such as FLW per capita, FLW per turnover, or FLW per amount of food sold.

An entity may use normalization to make FLW data more meaningful to stakeholders, compare data between FLW inventories, and/or better understand changes over time when multiple variables are changing. To illustrate, an entity may be interested in comparing household FLW in Brazil in 2010 relative to 2015. Because the population of Brazil increased by around 4 percent over this time period, comparing FLW *per capita* (in addition to comparing the change in the absolute amount of FLW) provides useful information when comparing these two years.

C2 Selecting a Normalization Factor

An important consideration in selecting the appropriate normalization factor is the audience an entity hopes to reach (e.g., the general public, policymakers, business executives) and what resulting information might be most relevant, given the focus and knowledge of the targeted audience.

Another consideration is whether the data for the selected normalization factor are considered reliable and available for the timeframe of the FLW inventory. If an entity plans to use the normalized FLW data for ongoing benchmarking and comparison against other entities' FLW inventories, then it should ensure that data on the normalization factor (e.g., number of citizens or employees) are available for those other entities as well. If using the normalized data for tracking FLW over time, an entity should, ideally, also be sure to use the most current data for the normalization factor.

The normalization factor should be aligned to the scope used to define FLW. For instance, if the scope of the entity's FLW inventory does not include associated inedible parts, then neither should the normalization factor (when the factor relates to a measure of food, such as amount of food processed).

Where an entity makes comparisons within or between entities—whether countries, businesses, or agricultural producers—normalization factors that have a strong relationship to FLW will be most useful for drawing meaningful conclusions. An example of a normalization factor in the United Kingdom that is known to be strongly related, and proportional, to household-level FLW is the country's "number of inhabitants." This means that if the number of residents increases by a certain percent, FLW levels are expected to increase by the same percent (all other factors being equal). Using "number of inhabitants" as a normalization factor would therefore be useful for comparing quantities of FLW generated by residents in different countries.

When making comparisons, the normalization factors chosen by an entity from one sector are not necessarily appropriate for use in other sectors. For example, while the number of inhabitants is likely to be a reasonably

good normalization factor for household FLW when comparing countries, the number of inhabitants in a country is less appropriate for comparing countries' agricultural sectors. This is because the size of a country's population is not closely linked to the amount of FLW generated by agricultural producers.

In summary, the best normalization factors:

- are meaningful for the intended audience of an FLW quantification study;
- have reliable data available for the time period of interest and other aspects relevant to the FLW inventory's scope (e.g., geography); and
- are strongly correlated with the level or type of FLW so they can support comparisons over time or between entities.

Table C1 lists possible normalization factors, the stage of the food supply chain in which they might be used, and some considerations.

Table C.1 | Potential Normalization Factors

NORMALIZATION FACTOR (I.E., DENOMINATOR)	APPROPRIATE STAGE(S)	COMMENT
Number of inhabitants (i.e., number of people in a geographic area)	Household	Population data are usually available and regularly updated Relationship between factor and FLW levels is usually proportional
Number of households	Household	Data on number of households are often available Relationship between this factor and FLW levels may be proportional but can be affected by differences in number of people per household
Food brought into the home (by weight)	Household	Dividing FLW by this factor yields the share of food brought into the home that becomes FLW. Although the relationship with FLW is not likely to be proportional over time, this yields useful information for putting FLW in context Data are not readily available in all countries
Amount of food sold, processed, or produced (by weight)	All (other than Household)	Dividing FLW by this factor yields the share of food that is FLW for a particular stage in the food supply chain. Although the relationship with FLW is not likely to be fixed over time, this yields useful information for putting FLW in context Care should be taken in using this factor to analyze FLW for a country if the country has a high level of imports or exports. Under such circumstances, a better factor to estimate the scale of FLW in the country may be created by dividing FLW by the amount of food consumed, or the total amount of food produced for consumption within the country, whether produced in that country or in another country A weight-based measure has the advantage over a monetary value because it is not affected by currency fluctuations, inflation, and different food prices around the world Care needs to be taken if an entity seeks to calculate FLW as a percentage of food across multiple stages in a food supply chain. It cannot do so by simply adding up the percentages from each stage (see Section 8.4 in the main text)

Table C.1 | Potential Normalization Factors (continued)

NORMALIZATION FACTOR (I.E., DENOMINATOR)	APPROPRIATE STAGE(S)	COMMENT
Turnover or revenue	All (other than Household)	Comparing the value of FLW with the value of food sold, processed, or produced can be useful for understanding financial impacts of FLW However, comparisons over time are affected by currency fluctuations and inflation. In addition, comparisons among different countries and businesses can be affected by factors including exchange rates, varying food prices, or seasonal and weather events that affect supply
Number of meals served	Hospitality and food service	As with amount of food sold, processed, or produced (by weight), this metric gives an indication of the flow of material through the sector and is therefore useful Care needs to be taken when making comparisons because serving sizes can vary, as can the definition of a meal
Number of visitors or patients	Hospitality or food service settings (e.g., hospitals)	Number of meals served (above) is likely to have a stronger relationship with FLW than number of visitors or patients However, data about this latter factor may be more readily available than data on meals or quantity of food served
Profit or value added (in local currency)	All (other than Household)	The relationship between these normalization factors and FLW is less direct and therefore they are usually less appropriate for comparisons of normalized FLW data over time or between entities. For example, some stores may stock more food in the same amount of floor space than other stores
Number of employees	All (other than Household)	
Floor space (square feet/square meter)	Retail, hospitality, and food service	
Number of sites or companies	All (other than Household)	

C3 Reporting and Communicating about Normalized Data

When normalization factors have been applied, it is good practice to report:

- the FLW inventory results before and after normalization factors were applied;
- a description of the normalization factors chosen;
- an explanation of why the factors were selected; and
- the source of normalization data (e.g., source of population data if the number of inhabitants of a country was used for normalization).

No single normalization factor will be perfect and it may be helpful for an entity to note any potential limitations of the normalized FLW data. For example, if comparing household FLW levels among countries, an entity may want to comment that the proportion of food eaten outside the home could differ greatly among the countries, which would affect household FLW levels. Similarly, if an entity draws conclusions about its FLW inventory results that are based on its analysis of the normalized data, it should include this fact in public reporting communications.

Appendix D. Expressing Weight of FLW in Other Terms or Units of Measurement

D1 Introduction

The *FLW Standard* requires FLW to be reported in terms of weight. An entity may also wish to express FLW in terms or units of measurement in addition to weight to convey, for example, environmental impacts, nutritional content, or financial implications. This decision is outside the requirements of the *FLW Standard*; however, this Appendix is included to provide general guidance for those seeking alternative units of measurement to describe and convey the scale and relevance of FLW in terms that may be more meaningful than weight to the intended audience.

This Appendix provides an introductory overview to expressing FLW in terms of:

- Environmental impacts
  - Energy use and greenhouse gas emissions
  - Water use
  - Land use
- Nutritional content
- Financial implications

For each of these, the Appendix provides technical considerations, examples of applications where FLW is expressed in these terms, and a sampling of resources that may provide guidance on approaches and factors to use in converting FLW from weight to some other unit of measurement. An entity should use the unit and conversion factor best suited to its particular situation and intended purpose. It should keep in mind that, when making conversions, additional assumptions are introduced that may increase the level of uncertainty around the reported data.

D2 General Considerations

When selecting a factor to use in converting the amount of FLW from weight to another unit of measurement, an entity should:

- understand the source of the factor and how it was created (including what the factor includes or excludes, and any limitations); and
- report on the approaches and data sources used.

The approach for converting the weight of FLW to another unit may be as straightforward as simply multiplying the weight of FLW by a single relevant conversion factor. In some cases, it might be necessary to use different conversion factors, even when converting to the same unit of measurement. For example, if an entity is seeking to convert FLW from weight to greenhouse gas emissions, and different food categories are included in its FLW inventory (e.g., meat and bread), each of these two food categories will require a different conversion factor. The ability to apply different conversion factors to the proportion of FLW represented by each food category depends on the level of detail known about the FLW.

In some cases, entities may find that different sources publish different factors for the same conversion. It may be appropriate to use the average value of the various factors, or to calculate a range by applying both the smallest and the largest factor.

An entity may also communicate about FLW using readily understood "equivalents." For example, the

weight of FLW could be expressed as the number of commonly weighed items (e.g., bags of sugar); in terms of physical items that can be lined up to stretch from one well known place to another (e.g., to the moon and back); or as a volume that can be portrayed as filling a local landmark (e.g., a sports stadium). Whatever equivalents are used, an entity should ensure that the equivalents chosen are meaningful to the target audience and enable the entity to develop accurate messages. It is important that an entity prepares clear and transparent documentation of its calculations because converting the weight of FLW into other units of measurement (e.g., length or volume) may be complex.

Entities can find further details about assessing the socio-economic and environmental impact of FLW in the report, *Criteria for and Baseline Assessment of Environmental and Socio-economic Impacts of Food Waste,* prepared by FUSIONS for the European Commission.[55] The report not only documents the existing knowledge base about socio-economic and environmental impacts, but also provides new information on how to proceed with socio-economic and environmental assessment of the impacts of FLW.

D3 Environmental Impacts

Greenhouse gas emissions, and water and land resources are "embedded" in food and drink products at all stages of the supply chain—from production and distribution to consumption and disposal. When FLW is reduced, embedded resource use is optimized. When no further value is captured from food that is removed from the food supply chain, the resources used to produce that food are also wasted. If FLW is sent to destinations where it is valorized, "avoided emissions" may be possible, for example, where the generation of methane released during decomposition is reduced. When an FLW inventory includes a detailed understanding of the FLW's lifecycle stages and destinations, the accuracy of the estimated impacts will be greater. Quantifying the embedded impacts can be a powerful way to understand and report on the importance of reducing FLW.

A global assessment of FLW's environmental footprint, *Food Wastage Footprint*, was produced by FAO in 2013 and updated in 2015.[56] It is a useful resource for assessing the impacts of FLW in terms of all three environmental impacts discussed in this section (i.e., energy use and greenhouse gas emissions, water use, and land use).

ENERGY USE AND GREENHOUSE GAS EMISSIONS

Relevance

FLW is responsible for two main sources of greenhouse gas emissions. The first is biogenic sources—emissions such as methane, related to agriculture and FLW decomposition. The second is combustive sources—emissions such as carbon dioxide, resulting from the combustion of fuels for energy use throughout a product's life cycle (i.e., at all stages—from growing food to cooking it). To understand embedded greenhouse gas emissions, it is therefore also important to understand energy use.

Technical considerations

Greenhouse gas emissions are often expressed as carbon dioxide equivalents (CO_2e or CO_2eq). This takes account of the mix of different greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide) and their different degrees of climate impact (also referred to as their "global warming potential" (GWP).[57] An entity must take care to use the correct units in reporting so as to not misrepresent the units used (e.g., "carbon dioxide-equivalent emissions" should not be abbreviated to "carbon dioxide emissions").

The Resources section below lists some sources of conversion factors that can be used to convert the weight of FLW to carbon dioxide equivalents. While an extensive literature has been published on greenhouse gas emissions associated with the production of different food and drink products, it is important to keep in mind that these studies often exclude certain lifecycle stages, such as waste management and land-use change. When using published data to estimate impacts, it is important to understand which lifecycle stages are covered by the conversion factors (and which are not, leading to data gaps), be transparent about such gaps when reporting results, and ensure that the data selected meet quality criteria. ISO14044 provides guidance on carrying out life cycle assessment, including data quality considerations.

When performing calculations in terms of energy, it is important to ensure that consistent units are being used. Energy can be expressed in a number of different units, including joules (J), kilocalories (kcal), kilowatt hours (kWh), and metric tons oil equivalent (toe). Tools are available for assisting with these conversions. For example, the United States Environmental Protection Agency has created a calculator for converting energy data into greenhouse gas emissions.[58]

It is also important to take into account the point at which energy data are generated to ensure consistency across calculations. For example, a fossil fuel used in electricity generation contains a certain amount of energy. When it is combusted and the energy converted to electricity, there are losses of energy, and further losses in the transmission of electricity. This means 1 kilowatt hour of electricity used by a household is equal to a larger amount of electricity at the point of generation, and a correspondingly larger amount of fossil fuel to generate the electricity.

Examples of converting FLW to measures of energy use and emissions

The following is a sampling of studies where FLW is expressed in terms of energy use or greenhouse gas emissions. Interventions to reduce FLW will affect energy use and greenhouse gas emissions to different degrees. The WARM tool (noted in the Resources section) allows users to estimate how greenhouse gas emissions would change as a result of different interventions, assuming refrigeration is in use.

- Webber (2012) estimates that food waste in the United States represents 2.5 percent of U.S. energy consumption per year.[59]
- Hall et al. (2009) estimate that the energy associated with the production of wasted food in the United States is equivalent to 300 million barrels of oil per year.[60]
- FAO estimates that the worldwide carbon footprint of food produced and not eaten is 4.4 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) and that food wastage ranks as the third largest source of emissions after the national emissions of the United States and China.[61]
- As part of its work for the EU-28, FUSIONS estimated food waste-related emissions to be 16–22 percent of the total emissions of consumed food (around 3.2 kg CO_2e per kg of consumed food).[62] These estimates reflect the two approaches applied, respectively referred to as the bottom-up and top-down approach.[63]
- WRAP in the UK estimates that the carbon dioxide equivalent emissions associated with wasted household food and drink in 2010 were 17 million metric tons CO_2e, around 4 metric tons CO_2e per metric ton of food waste.[64]
- Sakai et al. (2014) estimate that in Japan, 4.1 million metric tons CO_2e was emitted annually from food loss production. This is in line with earlier findings by Matsuda et al. (2012).[65]

Resources

Data on national energy use and greenhouse gas emissions may be held by governments and published on a regular basis. This could provide country-specific information on emissions and energy use for the food supply chain, although countries may not have specific numbers for FLW.

Various databases and life cycle assessment[66] tools also contain information on specific products. The European Platform on Life Cycle Assessment provides links to several resources as well as direct access to some data.[67] The Food Carbon Emissions Calculator is an example of a calculator that estimates greenhouse gas emissions related to production, transportation, and consumer waste for various foods produced in North America.[68]

The following is a sampling of resources that provide guidance on approaches and factors an entity may use in converting the weight of FLW to energy or greenhouse gas emissions:

- WRAP's *New Estimates for Household Food and Drink Waste in the UK 2012* contains information on the approach taken to calculate carbon dioxide equivalent emissions.[69]

- ISO 14067 provides guidance specific to greenhouse gas emissions.[70]
- The Intergovernmental Panel on Climate Change (IPCC) fifth assessment report provides conversion factors for different greenhouse gases to CO_2e, with and without feedback.[71]
- The U.S. EPA's Waste Reduction Model (WARM) and associated tools calculate greenhouse gas emissions from municipal solid waste compared with alternative options for managing the waste, or other interventions such as source reduction, anaerobic digestion, composting, or combustion. WARM offers users the choice of several material categories for FLW.[72] Three material categories are offered in the online calculator (with nine in the Excel version), namely:
  - non-meat, which represents the average life cycle of fruits and vegetables, grains (bread), and dairy products;
  - meat, which represents the average life cycle of poultry and beef; and
  - mixed FLW, which represents an average of the materials noted above.

WATER USE

Relevance

Food and drink production tends to be water intensive. Expressing avoided FLW in terms of the water "footprint," in combination with information about water stress, helps show the link between FLW and water-related issues, which have global social and environmental impacts.

Technical considerations

Unlike greenhouse gas emissions, the water footprint has the most profound effects at the local or regional level. These effects depend upon a number of issues, such as the availability of water, either geographically, or over time, and the efficiency with which water is used in agriculture and elsewhere in the food supply chain. Efficiency varies widely, depending on the technologies and management practices in place. An entity may use a water footprint assessment or a life cycle assessment approach.[73]

As a product moves from harvesting along the supply chain, its water footprint tends to increase. The footprint does not correspond to the amount of water in a product, but rather the amount of freshwater that has been cumulatively used in its production. Water footprints are also sometimes referred to as "embedded water" in the same way that greenhouse gas emissions are "embedded" in a product.

As with data on greenhouse gas emissions, if an entity uses published data to estimate a water footprint, it is important to understand which lifecycle stages are covered by the conversion factors (and which are not, leading to data gaps), be transparent about such gaps when reporting results, and ensure that the data selected meet quality criteria.[74]

Examples of converting FLW to measures of water consumption

The following is a sampling of studies where FLW is expressed in terms of water consumption:

- Hall et al. (2009) estimate that water embedded in wasted food in the United States is equivalent to 25 percent of the total freshwater consumed by agriculture in the United States.[75]
- FAO (2013) estimates that the global blue water footprint (i.e. the consumption of surface and groundwater resources) of food wastage is about 250 cubic kilometers, which is equivalent to the annual water discharge of the Volga River, or three times the volume of Lake Geneva.[76]
- WRAP and WWF (2011) estimate that the water footprint of 1 metric ton of avoidable food waste—defined as food and drink that, at some point prior to disposal, was edible—is more than 730 cubic meters water, which is equivalent to 6 percent of total UK water requirements.[77]

Resources

The following is a sampling of resources that provide guidance on approaches and factors an entity may use to convert the weight of FLW to water use:

- The Water Footprint Network develops and maintains WaterStat, a water footprint database containing statistics on product water footprints, national water footprints, international virtual water flows, water scarcity, and water pollution.[78]
- Boulay et al. (2013) provide a comparison of the water footprint approach with the life cycle assessment approach.[79]
- AQUASTAT is FAO's global water information system. It allows users to find comprehensive and regularly updated information on water resources, water uses, water stress, and agricultural water management at global, regional, and national levels.[80]
- ISO 14046:2014 specifies principles, requirements, and guidelines related to water footprint assessment of products, processes, and organizations based on life cycle assessment.[81]

LAND USE

Relevance

Productive land is a valuable resource that is in short supply in some parts of the world. Food (and its associated inedible parts) that is produced but ultimately removed from the food supply chain represents a waste of the land area on which it was grown. This is particularly significant in the context of an increasing global population and demand for food, which create pressure to convert forest or other natural land to farmland, with potentially negative environmental and social consequences.

Technical considerations

The data sources suggested below relate to average global land use. Given major differences in agricultural productivity around the world, the specific land requirements in different countries, regions, or localities will often diverge widely from the global average.

Examples of converting FLW to measures of land use

The following is a sampling of studies where FLW is expressed in terms of land use:

- FAO (2013) estimates that the embedded land in uneaten food is equivalent to almost 1.4 billion hectares of land, which represents close to 30 percent of the world's agricultural land area.[82]
- WRAP (2013a) estimates that food and drink thrown away by UK households represents embedded land (required for production in both the UK and abroad) equivalent to 19,000 square kilometers, or an area about 91 percent the size of Wales.[83]

Resources

The following is a sampling of resources that provide guidance on approaches and factors an entity may use to convert the weight of FLW to land use:

- The calculation of land use associated with food waste in the UK report by WRAP, *Household Food and Drink Waste in the UK 2012*, was based on land-use estimates in Audsley et al. (2009), Boucher et al. (2012), and DeVries and deBoer (2010).[84] These three studies may be of assistance in performing calculations in other countries or regions.
- The average global land area required to produce a unit of crops and animal products can be derived from the appendices to Mekonnen and Hoekstra (2011) and Mekonnen and Hoekstra (2012).[85]

D4 Nutritional Content

Relevance

FLW represents a loss of nutrients, which include carbohydrates, proteins, fat, vitamins, and minerals. Information on the nutrient-equivalent value of FLW can be useful when making comparisons. For example, when comparing FLW generated by different sectors of the economy in a single country, a comparison of the nutrients "lost" by each sector may be as important as understanding the respective weight of FLW per sector when prioritizing resources to tackle the issue.

In addition, information on the nutritional content of FLW can be a powerful representation of the scale of the FLW issue, especially in parts of the world where malnutrition is a problem. In some situations, the number of meals or portions can be more meaningful than weights of FLW (e.g., for the hospitality and catering sectors, or for national government).

Technical considerations

Many countries provide databases listing the nutrients contained in a given weight (usually 100 grams) of a wide range of foods. Examples of these databases are given in the Resources section. This information on nutritional content represents factors that can be applied to the weight of FLW to determine the total amount of nutrients wasted. If the nutrient information is "per 100 grams," these numbers can be treated as percentages for application to weight-based information.

To apply nutritional information to FLW, it is necessary to know the types of food within the FLW—the nutrients within a mixed stream of FLW will be very different from a stream that comprises mainly fruit and vegetables or another of mainly baked goods.

When applying nutritional information to FLW, it is important to check whether information refers to just food parts or to whole items (e.g. whether both the nutritional and the FLW information refer to a whole chicken—including its bones—or just the flesh of the chicken). Most nutritional information only refers to the "edible fraction," whereas FLW data may also include inedible parts associated with the food. If there is a mismatch (e.g., FLW information includes both food and the associated inedible parts), then the weight of inedible parts in the FLW should be excluded from the calculations.

In addition, the nutritional content of some foods changes upon cooking (e.g., dried pasta absorbs water). This would therefore reduce the energy content per 100 grams. Where possible, nutritional information should relate as closely as possible to the state of the material removed from the food supply chain.

Examples of expressing FLW in terms of nutritional content

The following is a sampling of studies where FLW is expressed in terms of nutritional content:

- In 2014, the USDA estimated the amount, value, and calories of the available but uneaten U.S. food supply at the retail and consumer levels in 2010.[86]
- Defra (2010) used information on household food waste from WRAP to calculate the proportion of nutrients purchased for consumption in the home that was subsequently wasted.[87]
- In COMCEC (2016), losses are expressed in terms of kilocalories for various crops and converted into the equivalent daily calorie needs for one year (based on an average of 2,500 calories per day) for the population of the country in which the crop in question is grown.[88]
- Lipinski et al. (2013) converted the amount of global food loss and waste (as defined by FAO) from kilograms into a caloric equivalent, and estimated that about 1 in every 4 calories produced for human consumption is lost or wasted.[89]

Resources

The following is a sampling of resources that provide guidance on approaches and factors an entity may use to convert the weight of FLW to nutritional value:

- A number of countries have nutrient databases, many of which are listed by the European Food Information Resource (EuroFIR).[90]
- The United States Department of Agriculture (USDA) publishes the National Nutrient Database for Standard Reference (NNDSR).[91]
- The FAO also publishes nutritional information as part of its International Network of Food Data Systems (INFOODS).[92]

05 Financial Implications

Relevance

FLW has significant financial implications along the entire supply chain in the form of direct costs and foregone benefits. FLW reduces business profitability and competitiveness and, based on results from a study of food waste in Canada, also translates to consumers paying more for food. Farmers' revenues and profits are also affected because the costs they incur are related to their entire crop, or livestock produced, regardless of how much product they sell.

In addition, there are often costs associated with collecting, processing, and disposing of FLW. In many countries, material that goes to a landfill incurs a tax. In some situations, FLW can be used to generate revenue (e.g., it can be used as a feedstock for anaerobic digestion or animal feed). The amount of this revenue is often much smaller than the costs outlined above, but it may be an important element in accurate quantification of the net cost of FLW to an organization or business. The scale of the financial costs and benefits (e.g., revenues) associated with FLW are important considerations in taking action and may form an integral part of a business case for reducing FLW.

In addition, costs to society can be calculated to take into account environmental externalities. There are often considerable environmental impacts associated with FLW, as described above, which can be monetized to help inform investment and policy discussions.

Technical considerations

When quantifying the financial implications of FLW, it is important to keep in mind that a complex set of variables affects economic value. When an entity seeks accurate estimates of potential financial gains or losses, factors such as the volatility of commodity prices as well as currencies should be taken into account to minimize the risk of making poor business decisions.

It is also important to be clear about which financial implications have been taken into account. Financial elements that could be considered for quantification include the following:

- price of the product purchased that is subsequently removed from the food supply chain;
- price of ingredients purchased (e.g., for food processors, the hospitality sector);
- price of other inputs (e.g., for producers, the cost of fertilizers and pesticides);
- price of labor;
- value of lost revenue (e.g., if 20 percent of produce is rejected due to poor quality);
- costs associated with collecting the FLW;
- costs (or revenues) from disposing of or treating the FLW; and
- costs associated with environmental impacts (e.g., greenhouse gas emissions, water use, land use).

For some of these elements, only a proportion of the costs are associated with FLW, and these should be proportionately allocated to FLW. For example, if one-fifth of the material processed in a factory is FLW, then it would be reasonable to allocate one-fifth of the operating costs of that factory (e.g., labor, inputs) to the FLW.

In the case of product prices, many governments publish information by type of food[93] that can be used to calculate the price of certain foods per metric ton (or other unit of weight), which can be applied to household FLW. Similarly, statistics on agricultural inputs can be used to calculate the cost of food and ingredients at other stages in the supply chain.

It is important to ensure that the cost factor being applied is appropriate for the food in question. For instance, some foods absorb water during cooking or are diluted in the home; where possible, cost factors should be modified to take these changes into account.

As with nutritional information, when applying financial information to FLW it is important to check whether information refers to food only, or to the food and its associated inedible parts. Both the financial and the FLW information should either refer to a whole orange—including its peel—or just the orange ("flesh"). Most financial information refers to the whole item (e.g., price per kilogram or metric ton of whole oranges) and therefore the factor may need modification to take into account (a) the fact that the majority of the economic value of the orange is in its flesh, and (b) the mix of food and associated inedible parts within the FLW stream.

Examples of expressing FLW in terms of financial costs

The following is a sampling of studies where FLW is expressed in terms of the financial cost:

- FAO (2013) estimated the cost of global FLW by region and by commodity type.[94]
- WRAP estimated the amount of money spent by UK households on food that is subsequently wasted,[95] the cost to retailers and manufacturers of food and packaging waste,[96] and the costs to the hospitality sector associated with food waste in terms of energy, water, labor, transport, administration, and waste management, as well as the purchase of ingredients.[97]
- The cost of food waste in all sectors in South Africa was calculated in Nahman et al. (2012).[98]
- Gooch and Felfel (2014) estimated the value of annual food waste in Canada to be Can$27 billion in 2010 and Can$31 billion in 2014.[99] The report also contains resources that may be useful to entities undertaking their own valuation.

Resources

The following is a sampling of resources that provide guidance on approaches and factors an entity may use to convert the weight of FLW to monetary value:

- Information on intermediate (e.g., raw material) prices of food and ingredients often forms part of trade statistics (e.g., Eurostat),[100] while statistics on consumer prices may be found in different datasets maintained internationally (e.g., Eurostat)[101] or produced by individual countries.
- WRAP (2013d) presents a methodology for calculating the price of food purchased by UK homes.[102]

Appendix E. Quantifying and Reporting the Weight of Food Rescued

E1 Introduction

The *FLW Standard* aligns with the universal recommendation to prioritize prevention of FLW. Prevention includes rescuing safe and wholesome food that would otherwise be removed from the food supply chain, and distributing it to people in need. Rescuing food is important because it helps address the problem of hunger.

Where financial incentives exist (e.g., a tax deduction), donating edible food that has not been sold helps to offset the economic consequences of not selling food that has already been grown, purchased, warehoused, transported, and/or prepared. Rescuing food also avoids some of the negative impacts associated with managing FLW (e.g., greenhouse gas emissions when food decomposes) and optimizes the use of resources embedded in the production and distribution of food. Given the importance of diverting surplus wholesome food to people and keeping it within the food supply chain, this Appendix provides general guidance on quantifying and reporting the weight of food rescued.

Food rescue may take place through formal programs or informal efforts (that may also be referred to as food recovery, redistribution, or donation). Collection may take place at any point along the food supply chain, such as at the farm (e.g., field gleaning),[103] the food processing facility, or the food distribution outlet (e.g., supermarket, restaurant).

There are various reasons why countries, companies, and other entities quantify and report the weight of food rescued. They include demonstrating corporate citizenship, and monitoring progress toward targets to increase the amount of food rescued over time.

The weight of food rescued may be quantified by the entity that donates it (also referred to in this Appendix as the "donor"). In other cases, it may be the entity that collects or receives the food for distribution to people in need that quantifies the weight on behalf of the donor.

It is important to note that the weight of food rescued **shall not** be included in an entity's FLW inventory. This is because an FLW inventory is focused on material no longer in the food supply chain whereas rescued food is still within the food supply chain. Consequently, users of the *FLW Standard* are required to record data about rescued food separately from their FLW inventory results.[104]

E2 Steps for Quantifying the Weight of Food Rescued

In order to quantify the weight of food rescued, an entity should use some of the same steps that would be undertaken to prepare an FLW inventory. It should:

- use the accounting and reporting principles of relevance, completeness, consistency, transparency, and accuracy as a guide for its decisions;
- clearly define and describe the scope of what will be included in the quantification;
- decide who will undertake the quantification and select the method(s) for quantifying the weight; and
- gather and analyze the data to calculate and report the total weight.

Other possible steps include identifying and documenting sources of uncertainty that arise during calculation. If a high level of accuracy is required, a process to review and verify the data should also be in place. An entity may track the amount of food rescued (e.g., in total weight, or as a percentage of unsold food) with the goal of increasing the amount over time. It may use the steps recommended for an FLW inventory to set targets and track progress.

E3 Guidance: Defining and Describing the Scope

When reporting the amount of food rescued, an entity should define and report the scope of what is included in its quantification. The first step is to clearly define what it considers to be rescued food.

The Food and Agriculture Organization's (FAO's) definition of "recovery and redistribution of safe and nutritious food for human consumption" is included in Box E1. According to FAO, recovery and redistribution may take place with or without payment. Other entities, however, may not consider food to be "rescued" if payment was received (even if at a significant discount or in an aftermarket).

As another example, in the United States, the industry-led Food Waste Reduction Alliance (FWRA) uses the term "unsaleable food" in its survey of retailers and manufacturers. This is considered: "food that is perfectly safe for consumption, but not saleable due to quality, over-production, or labeling issues. It may include packaged or fresh food items, product ingredients, and semi-finished products. It excludes, however, food that is produced expressly for donation, purchased by customers or employees expressly for donation, or donated to organizations if it is still suitable for retail sale."

The scope reported should also include the following components, which are similar to but not exactly the same as those used in preparing an FLW inventory:[105]

- **Timeframe**. Including starting and ending date
- **Material type**. An entity may find it useful to know whether the entire weight of what was rescued is food (i.e., intended for human consumption), or whether inedible parts are included, which implies that some fraction of the weight is not intended to be eaten
- **Boundary.**
  - Food category, if an entity is interested in a deeper understanding about the type of food rescued (e.g., fruits and vegetables, bakery, fish, and meat)
  - Lifecycle stage. There will be only one stage for commercial entities reporting the weight of food rescued from their operations. However, if the weight of food rescued is quantified across multiple stages (e.g., by a nation), multiple lifecycle stages may be involved
  - Geographic borders
  - Organizational unit (e.g., number of acres from which crop is gleaned, number of stores donating food)
- **Packaging**. Included in or excluded from the weight

Box E1 | FAO Definition of "Recovery and Redistribution of Safe and Nutritious Food for Human Consumption"

Recovery *of safe and nutritious food for human consumption:*
To receive, with or without payment, food (processed, semi-processed, or raw), which would otherwise be discarded or wasted from the agricultural, livestock, and fisheries supply chains of the food system.

Redistribution *of safe and nutritious food for human consumption:*
To store or process and then distribute the received food pursuant to appropriate safety, quality, and regulatory frameworks directly or through intermediaries, and with or without payment, to those having access to it for food intake.

Source: The online Technical Platform on the Measurement and Reduction of Food Loss and Waste, accessible at: http://www.fao.org/platform-food-loss-waste/food-waste/food-waste-reduction/country-level-guidance/en/.

In the case of an FLW inventory, the weight of any packaging is required to be *excluded*. However, when reporting on the weight of food rescued, the entity that will be using the data should decide whether the weight of packaging is to be excluded or included (e.g., it may determine that the weight of packaging will not have a material effect on the total weight). The approaches described in Section 8.3 in the main text to exclude the weight of packaging in an FLW inventory may be applicable to excluding the weight of packaging from food rescued.

It is important for the sake of transparency and improved comparability that an entity clearly report whether the weight of packaging is included or excluded in its quantification of food rescued. If a calculation is used to separate the weight of packaging from that of the food rescued, the approach and calculation used should be described. If packaging weight is included, it should report the weight (or estimated percentage) of packaging.

E4 Guidance: Selecting the Method(s) for Quantifying the Weight

When selecting the method(s) for quantifying the weight of food rescued, an entity should take into account the degree of accuracy desired and the kind of information—besides total weight—that it wants to track. For example, an entity may wish to track and report data concerning the food categories rescued, the organizational unit from which the food was rescued (e.g., farm, store, municipality), or the geographic region from which the food was rescued or to which it was redistributed. More granular data enable an entity to gain insights into how it can maximize the amount of food rescued to feed people.

There are multiple ways to calculate the weight of food rescued. A number of the methods included in the *FLW Standard's Guidance on FLW Quantification Methods* (e.g., direct weighing, counting) are also applicable to quantifying the weight of food rescued even though the guidance in that document is focused on quantifying FLW. This section of the Appendix provides additional guidance that is specific to food rescued.

The most direct method of quantification is for an entity to weigh the food rescued. Alternatively, if the net weight of individual items is known (i.e. the weight of the food excluding any packaging), an entity may count the number of items rescued, and multiply the number by the net weight of each individual item. For example, if a food service distributor donates canned tomatoes, the net weight of each can (e.g., 450 grams excluding the can) is multiplied by the number of cans.

If an entity uses scanning technology linked to printed or digital bar codes, it may scan the food rescued (these are often packaged food items) and record the data in terms of individual items, cases, or pallets of product. The number of units scanned may be converted to weight using standard product weight data linked to the bar code. The donor of the food may undertake this conversion. Alternatively, the file with relevant details may be transferred to the entity that has collected (or received) the rescued food, or to another third party that performs the calculation on behalf of the donor or the recipient. The latter case is common in situations where food is regularly rescued and there is an ongoing relationship between the two entities.

In cases where an entity donates "bulk" items (e.g., crops gathered from gleaning at a farm, ingredients used by a food manufacturer) or items without standard product weights (also referred to as "loose products"), it may need to separately estimate the weight of these items. This can be done in a number of ways. One option is to keep a log for a period of time to record the actual weight of individual items rescued. The entity can then calculate an average weight for each item or an average weight of some other specific unit, for example, a standard container used to sell or store the item.

In cases where only the economic value of the rescued food is known, an entity may use a conversion factor to convert the economic value to weight. It may develop its own conversion factor if it has sufficient data about the weight of individual items or of a product category. For bulk or loose items, it may divide the retail value of the food (or product category) rescued by the average "price per pound or kilogram."

An entity may also use a conversion factor developed by a third party, which could be specific to a certain industry sector or type of product, or a more generic national average. In the United States, for example, Feeding America (a network of food banks) calculated the national average wholesale value of one pound of donated product to be approximately $1.70 in 2015.[106] To estimate the weight of rescued food, an entity divides the economic value by the conversion factor (in this case, 1.7).

E5 Other Considerations Related to Food Rescue

A number of other aspects related to rescuing food are useful for an entity to keep in mind.

NATIONAL POLICIES TO SUPPORT FOOD RESCUE

Globally, there is growing interest among governments in establishing policies that encourage the rescue of surplus food. Specific policies are in place in some European countries,[107] Mexico, and the United States. In the United States, for example, measures include enhanced tax benefits based on the fair market value and cost of the food donated as well as federal legislation to protect donors from liability.[108] France now requires all food retailers with retail space of more than 400 square meters to sign a donor contract with one or more food bank associations for the recovery of their unsalable food products.[109]

OTHER WAYS TO EXPRESS BENEFITS FROM FOOD RESCUE

An entity may be interested in expressing food rescue in units of measurement other than weight or economic value, for example, in terms of the environmental benefits. One option is to use the Waste Reduction Model (WARM) developed by the United States Environmental Protection Agency, which estimates the energy and greenhouse gas emissions avoided through food rescue.[110]

Expressing food rescue in terms of "meals" is also a common metric. This involves using a conversion factor, or ratio, based on the average weight of a meal. For example, food retailer Tesco in the United Kingdom uses a ratio of 420 grams to 1 meal, a ratio provided by its partner charities. Such a ratio can then be used to calculate the amount of food rescued in terms of equivalent meals.[111]

DEVELOPING A FOOD RESCUE PROGRAM

Developing a food rescue program requires addressing multiple issues. The issues vary by industry sector but typically include the following:

- Logistics related to storing rescued food and its collection by (or delivery to) another entity.
- Technology to track food rescued.
- Food safety, which is critical in managing rescued food and minimizing the risk of distributing or serving unsafe foods. Examples of useful references on food safety developed by U.S. organizations include the *Retail Food Safety Guidelines* produced by Feeding America,[112] and resources for rescuing prepared perishable food developed by the Harvest Support Network.[113]
- Partnerships needed for the program to succeed, which may include a range of community and regional entities. The Global FoodBanking Network manages a list of food bank organizations around the world. In the United States, a more detailed list, searchable online by zip code, is available from Feeding America. Another useful resource is the Food Surplus Entrepreneurs Network, which highlights social innovators (primarily in Europe) focused on reducing food waste or using food surplus.
- Perceptions of risk and legality, as well as cultural attitudes that may present barriers to rescuing surplus, wholesome food. One resource that includes ideas, relevant to the United States, on how to overcome such barriers to donations is the *Best Practices and Emerging Solutions Guide*, focused on the retailing, manufacturing, and foodservice sectors and developed by the Food Waste Reduction Alliance.

Glossary

This table provides a summary of the terms and definitions used throughout the *FLW Standard*.

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Account for	To quantify FLW with the intention of reporting the results		
Accuracy	The closeness of an estimate to the "true" value (i.e., the value that would be obtained by a perfect measurement)	The principle of accuracy ensures that the quantification of FLW is systematically neither more nor less than actual FLW, as far as can be judged, and that uncertainties are reduced as far as practicable. Accurate estimates enable users to make decisions with reasonable confidence as to the integrity of the reported information	
Approximation	A type of quantification that involves approximating the weight or volume of FLW, which generates estimates that are close to the actual amount of FLW but are less accurate than if it had been measured (see also "Measurement")	An approximation would normally be made where measurement is not possible. For example, "visual scales" can be used to approximate postharvest losses at the farm, storage, or trader level. In a household FLW study, a respondent may report "spoonfuls" or "platefuls"	
Base year	The timeframe (e.g., year) against which an entity's FLW is tracked over time	This is usually established before any effort to influence the amount of FLW has been made	
Bias	Refers to "systematic errors" in the estimates	For instance, if sampling of households omitted apartments/flats, this would introduce a bias into the results	
Entity	A broad term encompassing any party that develops an FLW inventory	This standard is designed for entities of all types and sizes, across all economic sectors, and around the world Entities include intergovernmental agencies, governments (e.g., nations, states, and cities), industry associations, companies, agricultural producers, and others	
FLW-producing unit	The discrete entity that generates FLW This may be a household, a business, an individual site (e.g., a production site, a grocery store), or a known area of agricultural land	The combination of all the FLW-producing units makes up the total population for which FLW is quantified	

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Food	Any substance—whether processed, semi-processed, or raw—that is intended for human consumption "Food" includes drink, and any substance that has been used in the manufacture, preparation, or treatment of "food"[a]	"Food" includes material that has spoiled and is therefore no longer fit for human consumption "Food" does not include cosmetics, tobacco, or substances used only as drugs "Food" does not include processing agents used along the food supply chain, for example, water to clean or cook raw materials in factories or at home The term "edible" may be used by other entities to mean the same as "food." If an entity substitutes any other term to mean the same thing as "food," this should be disclosed	Adapted from Codex Alimentarius Commission (2013)
Food loss and waste (FLW)	Food and/or associated inedible parts removed[b] from the food supply chain	For the sake of simplicity of expression, the FLW Protocol uses the phrase "food loss and waste" and the abbreviation "FLW" as shorthand. It does not differentiate between "food loss" or "food waste" The *FLW Standard* can be applied to both food and/or associated inedible parts removed from the food supply chain. In order to be in conformance with the *FLW Standard*, an entity is required to identify whether it is accounting for and reporting on both of these material types, only food, or only associated inedible parts. The choice an entity makes is a function of its goals for quantifying FLW There is no universal agreement on what "destinations" of food and associated inedible parts that are removed from the food supply chain are to be considered "loss or waste"[c] While the *FLW Standard's* definitions align with the FAO's definitions for "food," "inedible parts," and "food supply chain," the FAO's use of the term FLW refers only to "food" and therefore excludes inedible parts. Moreover, FAO's definition of "loss and waste" encompasses all 10 destinations defined by the *FLW Standard* The *FLW Standard* can be used across the alternative definitions for food loss and waste	

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Food Loss & Waste Protocol (FLW Protocol)	A multi-stakeholder effort to develop the global accounting and reporting standard for quantifying food and associated inedible parts removed from the food supply chain	Launched in 2013, its mission is to develop an internationally accepted FLW accounting and reporting standard and tools, which will enable users to be better informed and motivated to take appropriate steps to minimize FLW	
Food Loss and Waste Accounting and Reporting Standard (FLW Standard)	Requirements and guidance to account for and report on the amount of FLW	Also referred to as the *FLW Standard* or simply "standard" This standard provides a set of accounting and reporting requirements, universally applicable definitions, and recommendations and guidance on quantification methods. In so doing, it helps ensure consistency, enable comprehensiveness, facilitate comparability, and support transparent disclosure of FLW inventories within and among entities	
Food supply chain (FSC)	Connected series of activities to produce, process, distribute, and consume food	For the purposes of the *FLW Standard*, the verb "produce" is defined as the moment when the raw materials for food are ready for harvest or slaughter (i.e., ready to enter the economic and technical system for food production or home-grown consumption). Section 6.7 provides examples of what might be considered "ready for harvest or slaughter"	Adapted from FAO (2014); FUSIONS (2014a)
Inedible parts	Components associated with a food that, in a particular food supply chain, are not intended to be consumed by humans	Examples of inedible parts associated with food could include bones, rinds, and pits/stones For the purposes of the *FLW Standard*, "inedible parts" is equivalent to FAO's term "non-food parts of food plants and animals;" the parts of food plants and animals that are not intended to be consumed by humans Inedible parts do not include packaging, such as boxes, wrapping or plastic containers What is considered inedible varies among users, changes over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography In some sectors, inedible parts may also be referred to as by-products, or co-products	Adapted from FAO (2014)

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Inference by calculation	Involves taking existing data and manipulating it computationally to produce estimates of FLW	This is primarily a desk-based approach to quantifying FLW Inference by calculation includes deducing FLW from non-FLW data (e.g., inputs and outputs from a manufacturing process), applying factors with known relationships to FLW (e.g., through models), or using another entity's FLW data as a proxy to develop estimates of FLW It does not involve measuring or approximating FLW, although the data on which the inference is based are likely to have been measured or approximated	
Intended for human consumption	Original purpose of a substance in the food supply chain, namely, to be ingested as food by the final consumer	For the purpose of the *FLW Standard*, "intended for human consumption" includes substances that are "reasonably expected to be eaten by humans" Whether plants, fungi, animals, or their parts are intended for human consumption depends on the food supply chain, the food system, and the geographical and cultural context In some cases it may not be known from the outset whether or not a substance will end up as food and intentions may change as a substance proceeds along the food supply chain. The *FLW Standard* gives guidance on what to do in those circumstances	Adapted from FAO (2014); FUSIONS (2014a)
Inventory	Output from the process undertaken to develop a quantified list of FLW as defined by the scope of the *FLW Standard*		Adapted from the Greenhouse Gas (GHG) Protocol[d]
Inventory report	A report that describes in a transparent way an entity's FLW inventory results plus other elements required to be reported in conformance with the *FLW Standard* (e.g., scope and quantification methods used)	A template for reporting on an FLW inventory can be found online at www.flwprotocol.org	
Inventory result	Quantified list of FLW produced by an inventory	The figures that express the amount of FLW (in weight) within an entity's scope, by the material type and destination	Adapted from the Greenhouse Gas (GHG) Protocol[d]

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Measurement	A type of quantification in which the amount of FLW is determined by using a measuring instrument or device marked in standard units, or by comparing it with an object of known size. Measurement of FLW is the preferred option for accuracy, but is not always possible for logistical reasons. (See also "Approximation")	This includes direct weighing, counting, and measuring the volume of FLW. Where measurement is not possible, approximation-based methods can be used	
Normalization	Involves dividing the quantity of FLW by a certain factor (i.e., a denominator) such as a number of individuals (e.g., national population), financial figures (e.g., company turnover), or amount of food sold	An entity would use a "normalization factor" to generate a metric such as FLW per employee, or FLW per amount of food sold	
Population	Refers to all the FLW-producing units within the scope of the FLW inventory	It is usually not possible to measure or approximate FLW from the entire population, in which case sampling from the population is required	
Quantification	The process of generating a figure to express the amount of FLW to enter into an FLW inventory	The *FLW Standard* provides guidance on three broad categories, or types, of quantification—measurement, approximation, and inference by calculation (see Chapter 7)	
Quantification method	The way in which the data are obtained, recorded, and analyzed for the FLW inventory	Methods include: ▶ Fundamental methods such as weighing, counting, and itemizing ▶ More complex research-based methods such as waste composition analysis, surveys, and interviews ▶ Inference-based methods such as modeling and mass-balance analysis	
Quantification study	The research, project, or initiative that is undertaken to quantify FLW. The study may also be used for purposes beyond quantification	Uses quantification methods that are based on measurement, approximation, and/or inference by calculation The output of the study takes the form of data that can be used to complete an FLW inventory. It may also include additional output such as information about causes of FLW	
Records	Individual pieces of data that have been written down or saved. They are often collected as a matter of routine	Records may be electronic or paper and include invoices, warehouse record books, waste transfer notes, and consignment notes. They are often created for reasons other than quantifying FLW, but may be useful for this purpose	

TERM	*FLW STANDARD* DEFINITION	COMMENT	SOURCE
Reliability	Reliability of data is related to the degree of uncertainty associated with it	A lower level of uncertainty means the data are more reliable, i.e., an entity can assume that they are close to the "true value" of FLW and rely upon them for decision-making	
Report (verb)	To record and share with others	An FLW inventory may be reported to various parties, including those responsible for setting the goals that triggered the reporting entity to develop an FLW inventory (e.g., corporate management, industry association, government agency)	
Sampling	Refers to the process of choosing a subset of FLW-producing units from a population and/or choosing a physical sample of FLW to quantify	The sampling process should ensure that the information collected from the sample is as representative of the wider population as possible It also needs to consider the period of time over which the sample data are to be collected (e.g., how many weeks' worth of FLW should be sampled) and when this sampling takes place	
Sampling frame	The listing of all units in the population from which a sample is selected	The subset of the sampling frame from which data are collected is referred to as the "sample"	
Scaling	The act of increasing data in a fixed ratio in order to reflect the full scope of an FLW inventory	Data are scaled up from a limited number of observations (e.g., data collected during sampling), in order to provide an estimate of the entire population and/or whole time period of the inventory	
Shall **Should**	Indicates a requirement for an FLW inventory to be in conformance with the *FLW Standard* Indicates a recommendation but not a requirement	The *FLW Standard* uses precise language to indicate which provisions of the standard are requirements ("shall"), which provisions are recommendations ("should"), and which provisions are permissible or allowable ("may")	Adapted from the Greenhouse Gas (GHG) Protocol[d]
Temporal	Relating to time	"Temporal effects" are effects that relate to time. "Temporal scope" is the same as timeframe	
Uncertainty (degree of)	The degree of uncertainty describes the likely difference between the estimate of FLW (what was quantified) and the "true" amount of FLW (i.e., the amount that would be obtained by a perfect measurement)	The difference between the two includes contributions from random uncertainties (e.g., from sampling only part of the population and then scaling up the results) and biases (e.g., using a quantification method such as kitchen diaries that systematically underestimates FLW levels)	

[a] The definition of "food" for the purpose of the *FLW Standard* is equivalent to the definition of "food" used in Codex Alimentarius Commission (2013). It states "*food means any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs*"

[b] The term "removed from" encompasses other terminology such as "exits," "lost to," or "diverted from"

[c] Bagherzadeh et al. (2014) take stock of available data on food waste and explores policies related to food waste in OECD countries

[d] WRI and WBCSD (2004)

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Endnotes

1. The FUSIONS project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under Grant Agreement No. 311972. http://www.eu-fusions.org/
2. Target 12.3 of the United Nations Sustainable Development Goals states: "by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses."
3. FAO (2011).
4. FAO (2015).
5. Kummu et al. (2012).
6. Kummu et al. (2012).
7. FAO (2015).
8. Such a development would resemble the way in which the Greenhouse Gas (GHG) Protocol's standards have been applied.
9. Pre-harvest losses are not within the scope of this first version of the *FLW Standard* but may be addressed in future work by the FLW Protocol.
10. What is considered inedible is a function of the particular food supply chain, may vary among users, may change over time, and is influenced by a range of variables including culture, socio-economic factors, availability, price, technological advances, international trade, and geography. Examples of inedible parts associated with food could include bones, rinds, and pits/stones.
11. Strictly speaking, the measurement is called "mass" and is expressed as pounds, kilograms, tons, metric tons (tonnes), etc. In colloquial terms, however, it is most often referred to as "weight" and the *FLW Standard* accordingly uses the term "weight."
12. MassDEP (2014).
13. The United Nations Sustainable Development Goals (SDGs) define aspirational global targets with each government setting its own national targets, guided by the global level of ambition but taking into account national circumstances. As drafted, Goal 12 of the SDGs is to: "Ensure sustainable consumption and production patterns." An accompanying target (Target 12.3) is: "by 2030, halve per capita global food waste at the retail and consumer level and reduce food losses along production and supply chains, including post-harvest losses."
14. CGF (2015).
15. European Parliament (2014).
16. "Food category" refers to the type of food included in the FLW inventory (e.g., meat, dairy, bakery products, type of fruit or vegetable). It should not be confused with "material type."
17. WRAP (2008).
18. For the purpose of the *FLW Standard*, valorization refers to extracting value from FLW, typically in the form of an output that can be put to some beneficial use (e.g., some FLW is converted to energy or fertilizer).
19. The *FLW Standard* includes in the destination of bio-based materials/biochemical processing the production of biodiesel (e.g. through rendering of fat, oil or grease). The definition proposed by FUSIONS, however, includes the production of biodiesel as part of its definition of "food waste," to promote from a resource efficiency perspective the use of this resource in food and feed applications. See: FUSIONS (2016).
20. For additional details see CGF (2015).
21. Resources for FLW management hierarchies include the U.S. Environmental Protection Agency's Sustainable Management of Food program, Bagerzadeh (2014), UNEP (2014), European Parliament (2014), and FUSIONS (2014a).
22. For additional discussion about food category classification sources, see FUSIONS (2014b, 105).
23. A summary sheet on the Central Product Classification System (CPC) is available from FAO and UN Statistics Division (2015, 39). An official annex developed by FAO is also available for use in agricultural statistics; see FAO Statistics Division (2014).

24. GS1, Global Standards, is a neutral, not-for-profit, international organization that develops and maintains standards for supply and demand chains across multiple sectors.

25. GPC is a rules-based, four-tier classification system for grouping products. The four tiers are Segment, Family, Class, and Brick (with attributes and attribute values). A Brick identifies a category incorporating products (e.g., crops) that serve a common purpose, are of a similar form and material, and share the same set of category attributes. Examples of a Brick code are included in Table 6.3. The GPC Brick code links to the product's GTIN (Global Trade Item Number), the 12- or 13-digit number that is contained in the UPC/EAN product barcode.

26. Website for United Nations Standard Products and Services Code (UNSPSC): http://www.unspsc.org/

27. Water content, or moisture content, is the amount of water contained in a food. It is usually expressed as a percentage of total weight. See Manitoba Department of Agriculture, Food, and Rural Development (n.d.) for more detail.

28. Packaging comes in various forms including boxes, wrapping, or plastic containers (edible packaging would be considered food because it is intended for human consumption).

29. An entity may discuss this decision with assurance providers, as needed, to determine the possible impact and relevance of the exclusion on the overall inventory report.

30. The FLW Protocol has not determined an appropriate de minimis threshold or benchmark of materiality, though users of the *FLW Standard* may elect to do so, or follow guidelines set by others.

31. Adapted from FAO (2014) and FUSIONS (2014a).

32. Strictly speaking, the measurement is called "mass" and is expressed as pounds, kilograms, tons, metric tons, etc. In colloquial terms, however, it is most often referred to as "weight" and the *FLW Standard* accordingly uses the term "weight."

33. USDA (2015).

34. See WRAP (2014, 150).

35. Random uncertainty refers to uncertainties that stem from variation around the true value. If the measurement of FLW were to be repeated many times, random uncertainties would mean that the measured values of FLW would cluster around the true value. In most FLW studies, the major contribution to random uncertainty comes from sampling because an entity will rarely be able to sample (a) from all FLW-producing units within the population of interest, or (b) for the entire timeframe specified in the FLW inventory. As there are natural variations in the quantity of FLW generated (a) between FLW-producing units, and (b) by a single FLW-producing unit over time, sampling leads to random uncertainty in the estimate produced.

36. Confidence intervals may also be estimated for other important quantities in addition to the total (e.g., subsets of that total). For instance, in WRAP's household food waste work, confidence intervals were calculated and reported for the total amount of FLW and for each type of food or drink (e.g., apples, bread).

37. A *p*-value is the probability of obtaining the observed difference (or a more extreme difference) when there is actually no difference between the two populations (or no change over time), assuming that the null hypothesis is that there is no difference between the two populations or change over time. It is also possible to calculate the probability that, for example, a target has been met.

38. In studies where a difference is expected as a result of an action that has been taken, the threshold for acceptance could be set much lower (e.g., $p \leq 0.10$).

39. When adding or subtracting two quantities, if the uncertainties associated with those quantities are independent of one another, one can take the square root of the sum of the values (i.e., Sqrt (10^2 + 10^2) = c. 14 metric tons (or 140% of 10 metric tons).

40. For example, see section 7.2 in Bell (1999).

41. Monte Carlo simulation is a form of random sampling used in uncertainty analysis that shows the range of likely results (estimates of FLW) based on the range of input values for the calculation. In order to perform a Monte Carlo simulation, input parameters (variables) must be specified as uncertainty distributions, rather than point estimates. The calculation is repeated many times with different input parameters used each time, drawn from the specified uncertainty distributions. The repeated calculations produce a distribution of the predicted output values (estimate of FLW), reflecting the combined uncertainty of the various input parameters.

42. This section is adapted from FUSIONS (2016).
43. These steps follow the outline presented in FUSIONS (2016).
44. See Chapter 11 of WRAP (2013d).
45. More details on power analysis can be found online. See, for example, http://www.biostathandbook.com/power.html, http://documents.software.dell.com/Statistics/Textbook/Power-Analysis. Calculators to determine sample size also exist: http://powerandsamplesize.com/Calculators/. However, entities that do not have sufficient expertise in statistics are advised to consult a professional.
46. It is important to keep in mind, when undertaking these calculations, that while there are 52 complete weeks in a year, the year has 365 days, and leap years have 366 days. This creates one or two extra days per year, respectively. Thus, there are 52 1/7 weeks in a normal year and 52 2/7 weeks in a leap year.
47. FAO (n.d.)
48. EuroFIR (n.d.)
49. At the time of publication, when searching the NNDSR online, the percentages for "refuse" are found by clicking on the tab labeled "Full Report (All Nutrients)" and scrolling down to the row labeled "Refuse" (where the percentage and description are provided).
50. However, as NNDSR was developed for use in the United States, it may not have information on all relevant items. The FLW Protocol has not reviewed the methods underlying the data.
51. Lynch (2012).
52. FAO (2011).
53. See "Refuse factors.xls" at: http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/Adept.zip.
54. FAO (2000).
55. FUSIONS (2015).
56. FAO (2013) and FAO (2015).
57. GWP is a factor describing the radiative forcing impact (degree of harm to the atmosphere) of 1 unit of a given greenhouse gas relative to 1 unit of CO_2.
58. This calculator is accessible at: http://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
59. Webber (2012).
60. Hall et al. (2009).
61. FAO (2015).
62. FUSIONS' definition of food waste includes food and associated inedible parts removed from the food supply chain, entering all 10 of the destinations used in the *FLW Standard* except for animal feed and bio-based materials & biochemical processing, which, for the EU's purposes, are called valorization and conversion.
63. FUSIONS (2015).
64. WRAP (2011). For this study, household food waste was defined as "including FLW contained in curbside refuse, curbside recycling, curbside food waste and mixed-organic collections, and household waste recycling centre (HWRC) residual waste."
65. Sakai et al. (2014); Matsuda et al. (2012).
66. Life cycle assessment is a scientific method used to quantify environmental impacts of all activities occurring over the life cycle of a product or service, from extracting natural resources to managing generated waste.
67. The European reference Life Cycle Database (ELCD) is accessible at: http://eplca.jrc.ec.europa.eu/.
68. Food Carbon Emissions Calculator is accessible at: http://www.foodemissions.com/foodemissions/Calculator.aspx.
69. WRAP (2011).
70. ISO 14067 is accessible at http://www.iso.org/iso/catalogue_detail?csnumber=59521.
71. IPCC (2013). Feedback refers to the diminishing ability of oceans and soils to absorb carbon dioxide as the climate warms. As greenhouse gas emissions continue to warm the climate, oceans and soils become increasingly saturated with carbon dioxide. Some carbon dioxide that, in a cooler climate, would have been absorbed by land and ocean sinks therefore remains in the atmosphere, causing additional warming.
72. Accessible at: http://www.epa.gov/warm.
73. See Boulay et al. (2013) for an example.
74. Data quality requirements can be found in ISO (2006).
75. Hall et al. (2009).
76. FAO (2013).
77. WRAP and WWF (2011).
78. WaterStat is accessible at http://waterfootprint.org/en/resources/water-footprint-statistics/.
79. Boulay et al. (2013).
80. AQUASTAT is accessible at http://www.fao.org/nr/aquastat/.

81. Accessible at: http://www.iso.org/iso/catalogue_detail?csnumber=43263.
82. FAO (2013).
83. WRAP (2013a).
84. Audsley et al. (2009); Boucher et al. (2012); DeVries and deBoer (2010).
85. Mekonnen and Hoekstra (2011); Mekonnen and Hoekstra (2012).
86. Buzby et al. (2014).
87. Defra (2010).
88. COMCEC (2016).
89. Lipinski et al. (2013).
90. Accessible at: http://www.eurofir.org/.
91. Accessible at: http://ndb.nal.usda.gov/ndb/foods.
92. Accessible at: http://www.fao.org/infoods/infoods/tables-and-databases/en/.
93. For example, in the UK, the Department for Environment, Food and Rural Affairs (Defra) publishes the Family Food Statistics: https://www.gov.uk/government/collections/family-food-statistics.
94. FAO (2013).
95. WRAP (2013a).
96. WRAP (2013b).
97. WRAP (2013c).
98. Nahman et al. (2012).
99. Gooch and Falfel (2014).
100. Eurostat is accessible at: http://ec.europa.eu/eurostat/data/database.
101. Eurostat comparative price levels of consumer goods and services are accessible at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services.
102. WRAP (2013d).
103. Field gleaning is the collection of crops from fields that have already been mechanically harvested or on fields where it is not economically profitable to harvest. See CFP Food Recovery Committee (2007) for more detail.
104. Any food that is rescued but subsequently removed from the food supply chain (i.e., not ultimately eaten) should be accounted for as FLW.
105. The components of an FLW inventory scope that are not relevant when quantifying rescued food are: "Destinations," which are only relevant to food removed from the food supply chain; the requirement to exclude pre-harvest losses because the food is not ready for harvest; and taking into account water added or removed from FLW.
106. The figure of $1.70 is based on Feeding America (2015). Guidance on determining the economic value of donated foods may also be available in related legislation (for example, in the United States, in the Consolidated Appropriations Act of 2016).
107. O'Connor et al. (2014).
108. In the United States, the Bill Emerson Good Samaritan Food Donation Act (Public Law 104–210) protects donating entities. The text for this act is available through the U.S. Department of Agriculture's website at: www.usda.gov/news/pubs/gleaning/appc.htm.
109. Sénat (2016).
110. See *Modeling Food Donation Benefits in EPA's Waste Reduction Model (WARM)*, accessible at: https://www3.epa.gov/warm/SWMGHGreport.html.
111. Tesco (2016).
112. Feeding America's guidelines are based on CFP Food Recovery Committee (2007).
113. Accessible at: http://www.harvestsupport.org/training.html.

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Pete Pearson, *WWF*
Jessica Rosen, *Yum Brands*

ABOUT THE CONSUMER GOODS FORUM (CGF)

CGF is a global, parity-based industry network that brings together the CEOs and senior management of some 400 retailers, manufacturers, service providers, and other stakeholders across 70 countries.

ABOUT FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)

An intergovernmental organization, FAO has 194 Member Nations, two associate members and one member organization, the European Union. Achieving food security for all is at the heart of FAO's efforts—to make sure people have regular access to enough high-quality food to lead active, healthy lives.

ABOUT EU-FUNDED FUSIONS PROJECT

FUSIONS is working towards a more resource efficient Europe by significantly reducing food waste. FUSIONS has 21 project partners from 13 countries, bringing together universities, knowledge institutes, consumer organisations and businesses.

ABOUT UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

UNEP sets the global environmental agenda, promotes the coherent implementation of sustainable development within the United Nations system and serves as an authoritative advocate for the global environment.

ABOUT THE WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT (WBCSD)

The WBCSD is a CEO-led organization of forward-thinking companies that galvanizes the global business community to create a sustainable future for business, society and the environment.

ABOUT WRAP (THE WASTE AND RESOURCES ACTION PROGRAMME)

WRAP is a charity based in the UK. Its mission is to accelerate the move to a sustainable resource-efficient economy through re-inventing how we design, produce and sell products; rethinking how we use and consume products; and re-defining what is possible through re-use and recycling.

ABOUT WORLD RESOURCES INSTITUTE (WRI)

WRI is a global research organization that spans more than 50 countries, with offices in Brazil, China, Europe, India, Indonesia, and the United States. WRI's more than 450 experts and staff work closely with leaders to turn big ideas into action to sustain our natural resources—the foundation of economic opportunity and human well-being.

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DISCLAIMER

The FLW Standard is designed to promote best practice FLW accounting and reporting. It has been developed through an inclusive multi-stakeholder process involving experts from nongovernmental organizations, governments, and others convened by the FLW Protocol Steering Committee. While the authors encourage the use of the FLW Standard by all relevant organizations, the preparation and publication of reports or program specifications based fully or partially on this standard is the full responsibility of those producing them. Neither the author organizations nor other individuals who contributed to this standard assume responsibility for any consequences or damages resulting directly or indirectly from its use in the preparation of reports or program specifications or the use of reported data based on the standard.

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Food
Loss + Waste
PROTOCOL

The Food Loss & Waste Protocol (FLW Protocol) is a multi-stakeholder partnership, which has developed the global *Food Loss and Waste Accounting and Reporting Standard* (or *FLW Standard*) for quantifying food and/or associated inedible parts removed from the food supply chain—commonly referred to as "food loss and waste" (FLW).

www.flwprotocol.org

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