1. Direct Weighing

1.1 Overview of the Method

Weighing is a well-established approach to measuring the weight[4] of an object and involves using a weighing device (e.g., a set of scales) to quantify amounts of FLW. Weighing may be used as a stand-alone method or in combination with other methods (e.g., waste composition analysis).

ADVANTAGES AND DISADVANTAGES

The main advantage of weighing is its accuracy, provided that the weighing device is calibrated and used properly. In addition, because an FLW inventory is required to be reported in units of weight, no inaccuracy will be introduced by making conversions from other units to weight. As a result, there will be very little uncertainty about inventory data when weighing is used.

The main disadvantages of weighing are the effort and costs involved, especially when measurement is required at more than one location. A weighing device must be purchased (or rented) and transported, and FLW must be sampled and moved to the device. From a practical perspective, weighing is often not feasible, despite its being the most accurate method for quantifying FLW.

LEVEL OF EXPERTISE REQUIRED

Although care and attention to detail are required, no particular expertise is needed to operate a weighing device and record the results. Similarly, any sampling of FLW should be done carefully but, if the standard's guidance is followed, no particular expertise is needed beyond the physical ability to move the samples. An entity should ensure that the team involved receives proper standardized instruction.

COSTS

Weighing can be costly if an entity is weighing FLW from more than one location. In addition to the initial purchase or rental of a weighing device, transport of the device and personnel can be cost-prohibitive, particularly in areas with poor vehicular access. The main constraints on weighing, however, are logistics and feasibility rather than cost.

> *Weighing may be used as a stand-alone method or in combination with other methods (e.g., waste composition analysis).*

1.2 Guidance on Implementing the Method

An entity that chooses to weigh FLW will need to follow a series of steps.

1. SCOPE THE STUDY

As Chapter 6 of the *FLW Standard* explains, 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. The scope of an entity's inventory—defined by the timeframe, material type, destination, and boundary—will dictate to a large extent the scope of the weighing exercise. Chapter 6 also describes how the scope chosen by an entity for its FLW inventory should be aligned with its underlying goals for addressing FLW.

2. SELECT THE MEASUREMENT DEVICE

A device for measuring weight, also referred to as a weighing machine, weighing apparatus, or set of scales, may be manual or electronic and will use one of various mechanisms including springs, strain gauges, and balance beams. The choice of weighing device is typically related to the range of weights expected, availability, cost, and practicalities of transport and operation (e.g., an electronic device requires a power source so, where power is likely to be a problem, a manual device should be used).

Weighing devices come in a range of sizes, from small portable scales to weighbridges designed for large vehicles. It is important to have access to scales that are appropriate to the weight range being measured.

3. DEVELOP A SAMPLING STRATEGY AND TAKE THE SAMPLE

In many instances it will be impractical to weigh all the FLW, in which case a sample of FLW should be taken and weighed. Guidance on sampling is provided in Appendix A of the *FLW Standard*.

4. TAKE THE MEASUREMENT

Before each weighing, it is important to ensure that the scale is properly set to zero (i.e., zeroed). This may occur automatically or the scale may need to be zeroed manually. The sample should then be carefully loaded on the weighing device, a little at a time if necessary, and the weight read off and recorded.

If weighing FLW in a container, the weight of the empty container (i.e., the tare weight) must be deducted from the recorded weight. This can be done by placing the empty container on the scales, resetting the scales to zero and then placing the FLW inside the container. Many electronic scales have a "tare feature" which resets the display value to zero when a container is placed on the load-receiving element. When the container is filled, the weight displayed will be that of the contents alone (i.e., the net weight). Another option is to weigh the empty container separately and deduct this weight from the recorded weight of the FLW in the container. This option is less preferable because it introduces additional handling as well as the risk of calculation error.

An entity should recalibrate its weighing devices regularly to ensure their accuracy. It should make sure that any calibration adjustment complies with laws and best practice (some countries may require weighing devices to be adjusted by an official government agency). It is good practice to use an object of known weight to regularly check whether the weighing device is working correctly.

There are many situations in which an entity can measure or approximate FLW through weighing. The three examples that follow cover different scenarios. Box 1.1 provides an example of a business weighing its own FLW.

The second example (Box 1.2) is focused on measuring FLW at the agricultural production stage. This example would be applicable to an assessment of FLW at harvest time, across a wide range of fruits and vegetables, using a series of repeated observations and a consistent framework. The aim of this type of study is to determine the weight of a crop left behind in the field after the harvest, taking into account seasonal variability.

Box 1.3 provides guidance about an approach in which FLW is weighed and analyzed across a number of stages in the food supply chain.

5. SCALE UP THE DATA

Where data have been produced from a physical sample of FLW or from a sample of FLW-producing units, they will require scaling up. Guidance on scaling is provided in Appendix A of the *FLW Standard*.

Box 1.1 | A Business Weighs Its Own FLW

SCENARIO: A business sets an FLW reduction target focused on the amount of FLW it sends to landfill.

ACTIONS: A set of large beam scales is used to weigh the business's waste container once a week, prior to its collection by a waste management company. Each week the 1.1 cubic meter wheeled container is pushed onto the scales and the weight read off and recorded. The weight of the empty container is deducted from the recorded amount and the amount is tracked week on week to determine progress against the target.

Box 1.2 | Measuring Fruit and Vegetable FLW at Harvest Using Longitudinal Observations

SCENARIO: A postharvest loss expert is interested in quantifying the amount of FLW associated with a fruit or vegetable crop at harvest. The approach involves taking repeated observations to account for temporal differences. It is adaptable to a wide variety of crops (e.g., cucumbers, pears, sweet potatoes) regardless of whether the harvesting is done by hand or by machine. Over time, standards of block size can be developed for individual crops or groupings like tree fruit, berry crops, and bush crops.

ACTIONS: One way to determine the amount of a crop left behind after the harvest is through a longitudinal observational study, which determines the weight of the FLW per area during harvest. The approach requires participation from the growers, and the use of equipment and labor.

Preparing for sampling

Several replications of field or orchard blocks of the same size are evaluated over the entire season. It is important to begin with the first harvest of a field or cultivar in a season so that the data are not confounded by FLW created during prior harvests. In addition, the first harvest is usually the highest yielding. Because harvesting styles vary by region and by grower, one day of active harvest in a non-study area could be observed in preparation for measurement, in order to be certain that the approach is appropriate to the specific crop. This is also a good time to mark off blocks in the field being harvested the next day.

Blocks should be for a single cultivar, their size and number selected such that they will all be harvested in one day. Blocks should be of a certain area, as opposed to a certain number of plants, due to differences in plant spacing. Fruit and vegetable crops tend to have several harvests over time for single cultivars and may overlap with additional cultivars in some cases. Regular harvesting crews should treat the block like the rest of the field; they should be given no additional instruction or training. The location and farm name should be recorded, as well as the cultivar, date, and weather. Sampling should take place immediately after the grower's regular harvesting crew passes through the blocks. The harvesting crew will have collected what they understand to be marketable according to their training in the standards required by the buyer.

Collecting the total mature crop

After the grower's crew collects the crop to be sold, sampling should begin of the crop left behind. Skilled labor should be employed in this specialized type of collection. Only physiologically mature crops that are not too small to be removed in subsequent harvests should be collected and evaluated. However, some crops are normally harvested immature and, in this case, the collection should focus on the immature physiological stage being harvested normally, and anything beyond that.

The entirety of the crop that meets the maturity requirements should be collected, including anything overripe or on the ground. Machine-harvested crops will necessitate hand harvesting to accomplish this. The sampling time for each block and the number of people involved should be recorded in order to determine the extra time it would take to collect the total mature crop, over and above the average harvest time.

Weighing and capturing the data

The amount of the crop that has been sampled from each block should be labeled and evaluated separately. The samples should be evaluated in the packing house or in a lab. Experienced inspectors will be useful, but may not be necessary. Instructions should be provided related to the inspection of samples (e.g., determining what is insect or disease damage and what "overripe" looks like, according to each crop). The aim of sorting is to differentiate what could still have been eaten from what was no longer suitable for consumption.

Data should be collected on:

- total weight of the crop left behind in the block;
- weight of the portion displaying incidence of minimal and significant pest and disease damage;

Box 1.2 | Measuring Fruit and Vegetable FLW at Harvest Using Longitudinal Observations (continued)

- weight of the portion that is overripe; and
- weight of the portion of the crop suitable for consumption, but not meeting size and shape standards possibly imposed by the buyer.

These data will indicate the underlying reasons for the particular fruit or vegetable being considered unmarketable by the harvesting crew.

If weighing devices are not available, estimation methods based on number of items or volume collected may be employed. These can be used to approximate the weight. Guidance on count-based and volume-based methods is provided in Chapters 2 and 3, respectively.

Box 1.3 | "Load Tracking" FLW across a Food Supply Chain

SCENARIO: A national authority is interested in tracking the amount of FLW associated with a particular crop across the supply chain. Load tracking is a common approach to use along part or all of the food supply chain. The approach results in data with a high degree of accuracy but is expensive and time-consuming. It would most likely be used when an entity wants to gain in-depth knowledge of FLW in a particular location and for a particular crop.

ACTIONS: The method relies on evaluating the quality and/or weight of a well-defined sample of the crop as it moves through a supply chain under conditions that are as near as possible to "normal" practice. To quantify FLW across multiple stages, the first step is to create the baseline (i.e., the weight of the specific sample that will be followed) so that it can be used for comparison as the crop moves along the supply chain.

This baseline is generally created by harvesting part of the crop from selected sample areas (see Box 1.2 for guidance on selecting sample areas) then scaling up the quantity produced from those sample areas in order to produce an estimate of the actual yield of the entire cropped area.

The researcher then physically follows the sample along the whole food supply chain as it journeys from the field to the processor, the trader, reseller, and eventually the consumer. He or she records the weight and quality of the sample at each point in the chain and compares it with the original weight. The resulting measurements will show changes in weight of the sample at every stage: transport from the field to the storage facility, loading into and out of the storage facility, processing operations and so on.

The process of load tracking requires the use of weighing equipment (in the field as well as at the farm, the storage site, processing or retailing facilities etc.), so skilled personnel and reliable equipment are a prerequisite. Load tracking will be easier if the crop is packaged in individual containers (such as boxes or barrels, or even a truck) that can be labeled and followed.

An example of how load tracking has been used is provided in the Food and Agriculture Organization of the United Nations' (FAO's) report Post-Harvest Fish Loss Assessment in Small-Scale Fisheries at http://www.fao.org/docrep/014/i2241e/i2241e.pdf.

Endnotes

4. 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* therefore uses the term “weight.”