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## **The FAO approach to food loss concepts and estimation in the context of Sustainable Development Goal 12 Target 3**

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### **ABSTRACT:**

FAO is undertaking a two-pronged approach to building a dedicated global database on post-harvest/slaughter food losses (up to the retail level), and providing country level support to measure, estimate or impute the pertinent data. Country-specific food loss indices will then be calculated, and geo-aggregated up to a global level index. These indices will measure and monitor progress against one of the two components of Sustainable Development Goal 12 Target 3 (denoted as SDG 12.3).

**Keywords:** Food Balance Sheets, Food loss estimates, Food production/supply chain, Post-harvest/slaughter losses, SDG target indicators.

### **1. Introduction**

Due to the notorious acute lack of reliable data, assessing the magnitude and the economic, food security and environmental impacts of food losses and waste is an extremely challenging task. Nevertheless, basic data and observations clearly point to the large obstacles these two phenomena pose to global sustainable development. Some estimates indicate that the equivalent of some 24 percent of all calories produced for human consumption per year<sup>1</sup> are lost or wasted. Reducing food losses and waste is, therefore, a combined opportunity to mitigate environmental impacts (particularly greenhouse gas emissions), manage resources (energy and water) and better meet the challenge of improving global food security by means of increasing food availability<sup>2</sup> and smallholder incomes. All this is even more evident when

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<sup>1</sup> Global food losses and food waste. FAO (2011).

<sup>2</sup> One counter argument, however, states that the more food is available the lower its price and therefore the more likely it is to be wasted.

considering the ever-increasing stresses on our planet's ecosystems, and the rising world population requiring more and more food.

The recently adopted SDGs<sup>3</sup>, reflecting the importance of food loss and waste, have included the specific target 12.3 which aims to halve per capita global food waste and reduce food losses (see the section on the SDG further down). To monitor progress against this target, a country and then global Food Loss Index will be calculated by FAO.

Generally speaking, loss is the result of unintended actions, decisions or situations; while waste results from some elements of a discretionary process. That said, food losses and waste both occur, to different extents, along the whole food production and supply chain<sup>4</sup>. Consequently, it is understood that the labelling of the "loss" and "waste" parts of the food production and supply chain in this paper, while mainly for convenience, does tend to denote where one or the other is more likely to occur, and is in line with the terminology of the indicator of SDG 12.3.

In less advanced food systems, food loss is the largest component and generally occurs along the production chain as a result of wide-ranging managerial and technical limitations in harvesting, storage/cooling, transportation, processing, and infrastructure. By contrast, and mostly in advanced food systems, waste is the largest component and generally occurs along the supply chain as a result of retailer/consumer decisions to discard food that still has value<sup>5</sup>.

This paper will focus on FAO's work on food loss data, in the context of SDG 12.3, with emphasis on the model-based estimations within the context of the compilation of the FAO Food Balance Sheets (FBS). The FBS is a framework where the central concept is that the supply of food items in quantities equals its utilization. Within this context, food loss is treated as one of the utilization components, and includes all the losses incurred in all the other FBS utilizations (such as animal feed, industrial uses, the seeding process)<sup>6</sup>. The data aggregated to build the food loss index, to monitor SDG 12.3, are those loss numbers (official or imputed) in the FAO FBS database. Consequently, food waste from retail to consumer (the first component of the SDG 12.3) is beyond the scope of this paper.

Furthermore, it should be noted that the term "food loss" in this paper refers to the primary quantities of crop and livestock commodities that can potentially be consumed by humans, either directly or after processing, and not to specific amounts of directly edible processed/derived products.

## 2. The two-pronged FAO approach to food loss data

Given the lack of reliable and nationally representative data on food loss as well as of an internationally agreed methodology for its measurement, FAO - in its role of custodian of the indicator(s) for measuring country and global progress towards reducing food losses and waste related to SDG 12.3 - is currently undertaking a two-pronged approach:

- 1) Assist countries in **collecting food loss data** along the production/supply chain (up to and excluding the retail level) by producing guidelines on cost-effective data collection methods and testing them in some pilot countries. This is an endeavour that will ensure global data coverage only in the long-term,

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<sup>3</sup> September 2015 (<http://www.un.org/sustainabledevelopment/development-agenda/>).

<sup>4</sup> The production chain in this paper is considered to be from the post-harvest/slaughter stage till, and excluding, the warehouse. While the supply chain is considered to be from, and including, the warehouse, to retail, then to point of consumption and, ultimately, to the consumer.

<sup>5</sup> Global food losses and food waste. FAO (2011)

<sup>6</sup> <http://www.fao.org/docrep/003/X9892E/X9892E00.HTM>

- 2) Assist countries in **estimating losses** of food-related crop and livestock commodities, within the framework of the Food Balance Sheets (FBS), using a hierarchical linear model, as an interim solution to filling data gaps.

Both ‘prongs’ involve post-harvest/slaughter food commodity quantity loss data (e.g. tonnes of wheat, apples, meat, milk) up to and excluding the retail level of the production/supply chain. Such data contribute to monitoring the second component of the SDG 12.3.

Work related to the first of the two-pronged approach, development of a methodology for food loss measurement in developing countries (based mainly on sample-derived estimations), is being undertaken under the research programme of the **Global Strategy to Improve Agricultural and Rural Statistics** (GS). It will suffice here to mention that measurement of post-harvest food losses proposed by the GS is aimed at identifying the most cost-effective methodological options to measuring losses at different stages of the food production/supply chain (farm, intermediary, and warehouse levels), distinctively for the main food items.

Furthermore, the **Nutrition Division** of FAO (ESN) is conducting case studies in a number of countries to identify critical points along the value chain which have the highest impact on the extent of food losses and to design the appropriate mitigation measures. These food supply chain analyses are an important pre-requisite in deciding the scope and focus of the sample surveys.

Work related to food loss estimation, the second of the two-pronged approach, using a hierarchical linear model, and in the context of the FBS, is being undertaken by the **Statistics Division** of FAO (ESS). As the SDG process is intrinsically country-driven, this work will ultimately involve the countries through direct collaboration.

### 3. The FAO proposal to modify the SDG 12.3 indicator

Target SDG 12.3 states that “*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.*”

To monitor progress against this target, the current proposed indicator, the Food Loss Index (FLI), only partially achieves this. This index is a quantity-based price-weighted aggregation of any available and reliable country-generated food loss data and, in their absence, of the model-based estimations. It is categorised as a Tier III indicator, meaning that the methodology, mechanisms and baseline involved have yet to be fully developed, tested and adopted.

Moreover, at a closer look, the food waste component of target SDG 12.3 is not covered at all by this indicator. The nature of the target with its two distinctly worded components, waste and loss, implies the identification of two separate indicators. While the two concepts are related and the precise boundaries between them may be blurred, differentiating between the two, however and as mentioned above, is important as they principally occur along different parts of the production/supply chain and are triggered by different dynamics which necessitate different methodologies for measurement and estimation.

In this context, and for the above reasons, FAO would like to highlight the need to have an additional indicator for the SDG 12.3 that will focus on monitoring the food waste component. Each of these two indicators will measure progress against their respective SDG target component by generating country level indices, and ultimately two global ones. A method of combining the two indicators, if feasible and significant, will be investigated at a later stage.

Furthermore, because these two proposed indicators require the introduction of new data measurement, estimation and collection methods, and potentially the establishment of new statistical programs of work at the country level, the close coordination of the FAO Statistics Division (ESS) with member countries will be essential to the success of this endeavour. National focal points and relevant national agencies charged with measuring progress on food loss and waste will be identified by coordinating with national SDG committees. Coordination and collaboration with other supranational and regional organizations (EU, World Resources Institute, UNEP, etc.) as well as with relevant private institutions will also be essential.

#### **4. Challenges to the measurement or estimation of food loss data:**

The challenge to measure or estimate internationally comparable food loss statistics is made all the more acute for the following reasons:

- **No internationally endorsed food loss standard concepts and definitions exist.** Several imprecise concepts and definitions, that differ in some key aspects (e.g. inclusion or not of non-edible parts; inclusion or not of food items destined to feed), are currently used and promoted by different key organizations. As a result non-comparable data across countries are generated, hindering any effective analysis.
- **Current methods for measurement of food losses have not proved effective in generating data.** The approaches proposed in these guidelines may be not so cost-effective and therefore are not being implemented by countries.
- **Nationally generated reliable food loss statistics are extremely scarce.** The proportion of official food loss data in the FAO FBS detailed database (the commodity-specific Supply and Utilization Accounts), over the last 25 years, amounts to only a mere 4% of total, the rest of the data cells (about 200,000) are all estimations. Considering that the FBS is a unique global database of time-series food loss data by country and commodity, the magnitude of the scarcity of reliable data is even more evident.

This lack of data is due to several factors which include the complexity of measurement along different stages of the production/supply chain; different distribution processes along the value chain for different commodities (e.g. pineapples follow a simpler chain than wheat); quality of the infrastructure (such as storage, transportation); the variation of weather/temperature patterns; and lastly, the actual investment (financial and human) that many countries do not appropriately make to measure and collect food loss data.

#### **5. The concept of food loss in FAO agricultural statistics:**

The food loss concept that should be reflected in FAO's statistical data<sup>7</sup>, and the basis of which it would like to propose for international consideration is:

*Food losses are all the crop and livestock human-edible commodity quantities that, directly or indirectly, completely exit the post-harvest/slaughter production/supply chain by*

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<sup>7</sup> As there is no internationally adopted definition of food loss, FAO cannot, therefore, be certain that the few countries that do report data on losses are doing so according to the FAO concept.

*being discarded, incinerated or otherwise, and do not re-enter in any other utilization (such as animal feed, industrial use, etc.), up to, and excluding, the retail level. Losses that occur during storage, transportation and processing, also of imported quantities, are therefore all included.*

FBS data for food availability and for food losses include the commodity as a whole with its non-edible parts.

Out-graded quantities (not meeting certain specifications in terms of quality and/or appearance) that re-enter the supply chain (as feed or any other utilization) are not considered losses. Pre-harvest and harvest losses are *a priori* excluded since agricultural production data provided by countries to FAO refer to quantities net of harvest losses. Waste/loss that occurs at the retail level and all along the supply chain till the consumer is also excluded.

Food, in the above concept of “food loss”, therefore refers to any substance, whether raw, processed or semi-processed (including drinks), that can be consumed by humans.

## **6. The Food Balance Sheets (FBS) and the food loss estimation model**

The noted food loss data scarcity emphasises the necessity to have a robust statistical model that can generate estimations to fill in the many data gaps, with as much reliability as possible. This is done in the FAO Statistics Division (ESS) within the framework of the FBS using a newly developed hierarchical linear model.

Very briefly, the FBS is a time-referenced food accounting framework whereby supply equals utilisation (in quantities). Each FBS is composed of numerous commodity-unique supply utilization accounts (SUA) that are balanced and aggregated, in primary equivalents<sup>8</sup>, by commodity ‘tree’ groups (e.g. wheat & wheat products). The supply side components are production, imports, and stock withdrawals, while some of the main utilization components are food (available for human consumption), animal feed, quantities destined for seeding, exports - and loss. The loss component does not refer exclusively to the “food” component, but covers all losses related to all the other components along the production/supply chain (such as quantities lost post-harvest on-farm, damaged while held as stock, lost during transport, and so forth). As already stated, very few of these loss data are obtained officially from countries, and so the vast majority has to be imputed. FAO, nevertheless, does request commodity-specific loss data directly from countries in the annual agricultural production questionnaires that are expedited to all countries. Furthermore, all possible sources of loss data, from official statistical websites to national publications and published studies, are continuously scrutinized.

As highlighted earlier, the FBS framework is the only tool currently available capable of implicitly validating data on food loss. In fact, through the FBS balancing mechanism, the resulting food loss estimates make use of the magnitude and reliability of the data for the other components (such as animal feed, industrial use, etc.)

The **hierarchical linear model** that is presently<sup>9</sup> used, as an interim solution, to estimate data gaps in food loss consists of four levels: the lowest is country-commodity

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<sup>8</sup> Processed foods are derived from their primary/parent commodities with extraction rates that can be calculated. In the FBS methodology these processed quantities are converted back into their primary equivalents using the inverse extraction rates. For example, 10 kg of flour are equivalent to around 13 kg of wheat (with an extraction rate of around 75%)

<sup>9</sup> In the past, two different estimation methods were used/tested with unsatisfactory results. The first one, estimated the losses simply as a ratio of food supply. The second method consisted of an econometric model with the loss ratios in the SUA/FBS, in log scale, as response to time and to crop and country specific factors (regional/individual/commodity groups, percentage of paved roads and GDP). However, results have shown a

specific estimates, followed by commodity-specific estimates, then food group estimates, and finally by perishable food group estimates. The coefficients in the model are estimated simultaneously to ensure they are consistent, and the resulting estimations are further validated through the FBS balancing process. To date, preliminary results have been produced but the model will be further refined by referencing case studies, reviewing empirical data, and by the review of national and international experts (such as the IAEG-AG<sup>10</sup>). Furthermore, FAO is poised to provide support and guidance to countries to enable the adaptation of the model to specific national data situations (e.g. by adding variables on quality of infrastructure and climatic conditions) in order to generate national estimates.

## **7. The food loss index (FLI)**

To monitor progress against SDG 12.3, and by using the official and imputed loss data in the FBS database, individual country indices will be calculated which will then be combined using specific weighting to produce regional and global aggregates of the Food Loss Index (FLI). These indices are Laspeyres quantity indices based on the sum of the base period price-weighted<sup>11</sup> quantities of the food loss data. The country index shows the relative level of the aggregate quantity of losses for each year in comparison with a base period.

The choice of prices as weighting factor, is due to the fact that using calories may produce bias by possible over estimates in calorie per capita (kcal/caput) terms, as not all the food quantities involved in these calculations, in the FBS framework and as explained above, are strictly destined for human consumption.

## **8. FAO country support in the context of SDG 12.3**

As the SDG process is intrinsically country-driven, the work carried out by FAO on food loss concept and methodologies of data estimations and index calculations will involve the countries through direct collaboration. A draft country-support programme of work focusing on the loss component of SDG 12.3 (the second of FAO's two-pronged approach) is being finalised, and includes:

- Promoting the FAO concept of food loss and related methodologies, and raising awareness on the links to SDG 12.3 (seminars and information/training material)
- Assessing national situations and capacities in food loss measurement (country/regional technical missions)
- Establish/strengthen data reporting and data exchange mechanisms between countries and FAO (e.g. online platform and questionnaire)
- Devising country-tailored food loss data estimation mechanisms and index calculations (in collaboration with the SDG national committee and the national statistical office) to monitor progress against SDG 12.3

## **9. Conclusions**

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poor predictive ability of the model highlighting the need for more reliable data and to use more sophisticated estimation techniques.

<sup>10</sup> The Inter-Agency and Expert Group on Food Security, Agricultural and Rural Statistics.

<sup>11</sup> International commodity prices (ICP)

In its role as custodian of the indicator(s) for measuring progress against SDG 12.3 FAO is undertaking a two-pronged approach comprised of assisting countries in developing techniques for measuring food losses along the production/supply chain; and in estimating missing data within the framework of the FBS.

The nature of the SDG 12.3 with its two distinctly worded components, waste and loss, implies that in reality two separate targets must be reached. For this reason, combining them both into one overall indicator will be problematic. As a solution, FAO is proposing the creation of two separate indicators and monitoring mechanisms distinguishing food loss and food waste. Furthermore, terminology, mechanisms and reporting must be defined and established with urgency to allow countries.

An internationally adopted concept of food loss (and waste) is essential to ensure global comparability and meaningful analysis.

The hierarchical linear model that is presently used, as an interim solution, to estimate data gaps in food loss, has shown encouraging results, but is nevertheless being fine-tuned (e.g. inclusion of exogenous variables such as climate and infrastructure).

The resulting estimations are further validated through the FBS balancing process. In fact, the FBS framework is the only tool currently available capable of implicitly validating data on food loss by making use of the magnitude and reliability of the data for the other components (such as animal feed, industrial use, etc.).

FAO country support should enable the generation of national food loss data necessary for the calculation of loss indices for monitoring progress against SDG 12.3.