



Food and Agriculture Organization  
of the United Nations

## SDG 12.3.1: Global Food Loss Index

METHODOLOGY FOR MONITORING SDG TARGET 12.3.

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THE GLOBAL FOOD LOSS INDEX DESIGN, DATA COLLECTION  
METHODS AND CHALLENGES

FAO STATISTICAL DIVISION

**METHODOLOGICAL PROPOSAL FOR MONITORING SDG TARGET 12.3. THE GLOBAL FOOD LOSS INDEX DESIGN, DATA COLLECTION METHODS AND CHALLENGES**

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Abstract

The Sustainable Development target 12.3 states “By 2030, to 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.” As co-custodians for this target, the FAO and UN Environment propose to have two separate indicators, taking leadership on the methodological development for food losses and food waste measurement respectively. In this light, the FAO developed a *Global Food Loss Index* (GFLI) monitoring Food Losses on a global level for a basket of key commodities in the food systems, including crops, livestock, and fisheries products. The index focuses on the supply stages of food chains and measures changes in percentage losses over time. The purpose of the index is to allow for policy makers to look at the positive and negative trends in food loss compared to a baseline year, in order to improve the food supply system efficiency against food losses.

This paper delves into the rationale of the index design and then presents the various elements of the methodology. The paper starts with the definitional framework and scope of the index, it illustrates the rationale for estimating losses as the percentage of food quantities removed from the supply chain. It illustrates the commodities basket, their selection criteria, the compilation of the index weights and the steps for calculating the index. The final section of the paper summarizes FAO’s two pronged approach to food loss data. The long-term approach is to support countries in collecting food loss data using the Global Strategy Guidelines and recommendations to develop loss surveys along the value chain. The second approach, applicable in the short term, is to assist countries in estimating food losses using model-based estimates within the Food Balance Sheets framework to fill the data gaps. For this, a high level description of the loss imputation model developed by FAO and used at international level will be provided.

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## ABBREVIATIONS

APHLIS - African Post-Harvest Loss Information System

CoP - Community of Practice Website

CPC - Central Product Classification

FAO - Food and Agriculture Organization of the United Nations

FLI/FLP - Food Loss Index / Food Loss Percentage

FLW - Food Losses and Waste

FSC - Food Supply Chain

GFLI/GFLP - Global Food Loss Index/Global Food Loss Percentage

GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit

GSARS - Global Strategy to Improve Agriculture and Rural Statistics

IAEG-SDG - Inter-Agency and Expert Group on SDG indicators

IFPRI - International Food And Policy Research Institute

NRI - Natural Resource Institute

NSO - National Statistical Offices

PHFLA - Post-harvest Food Loss Assessments

PHL - Post-Harvest Losses

PPP – Purchasing Power Parity

QA - Quality Assurance

QC - Quality Control

SDG - Sustainable Development Goals

SUA/FBS - Supply Utilization Accounts in the Food Balance Sheets

SWS – FAO Corporate Statistical Working System

TSU - Tertiary or final sampling units

UNEP - United Nations Environment Program

UNSD - United Nations Statistics Division

## 1. Overview of the SDG Target 12.3

The objective of the Sustainable Development Goal (SDG) 12 is to ‘Ensure sustainable consumption and production patterns’, with the more specific Target 12.3 which aims, “by 2030, to 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.” The indicator for this target (Global Food Loss Index) was categorized as a Tier III indicator, meaning that the methodology, data collection mechanisms and a baseline needed to be fully developed, tested and adopted. This paper proposes the methodology for the Global Food Loss Index developed by FAO to measure and monitor losses for its up-grade to Tier II.

The custodian agencies, FAO and UNEP, have proposed to split the target 12.3 into two stages with the first focus on the *‘reduction of losses along the food production and supply chains’ (supply oriented)* and the second to measure the *‘halving per capita global food waste at the retail and consumer level’ (demand oriented)*. The nature of the target with its two distinctly worded components, waste and loss, implies the identification of two separate aspects of an efficient sustainable food system, with different policy tools and objectives. While the two concepts are related and the precise boundaries between them may be blurred conceptually, for operational clarity and measurement and to bring more effective and efficient outcomes, it is necessary to separate the supply and the demand sides of the matter.

The above conceptual simplification stems from the definitional framework<sup>1</sup> and from consensus among countries, whereby losses are due to a deterioration or disappearance of the product mainly caused by the (mal)functioning of the food production and supply system which tend to affect lower income countries. Whereas, waste is the removal of food that is fit to consumption mainly due to economic or social behavior, which is more characteristic of higher income countries with high consumption levels. In this regard, both losses and waste occur at every stage of a food chain and the distinction is not always clear. For a simplification in measurement, the amounts that leave the chain are counted at the point of removal, regardless of waste or loss and can be further assessed after the quantitative measures are taken.

Within the preliminary research, the distinction between the two has indicated a systematic divide between countries that are challenged by production losses and adequate domestic supply and see losses in terms of food security; and those where losses and waste are concentrated at the consumption level and see the issue in terms of environmental impact. Looking at food removed (regardless of intentionality) by stages, will focus the related policies and help focus the data collection efforts.

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<sup>1</sup> FAO Definitional Framework (2016). Unpublished. This document is the result of a 3-year consultative process with national and international stakeholders and experts.

It is therefore proposed to have an indicator 12.3.1 Global Food Loss Index (GFLI) and an indicator 12.3.2 Global Food Waste Indicator (GWLI), which still under development. FAO, as a custodian agency for SDG 12.3.1 Global Food Loss Index, seeks an objective, direct, and nationally representative measurement.

This document describes the steps for calculating the index along with a method to aggregate data from subnational stages of the supply chain to the national level. Subnational disaggregation will identify where losses occur and the scope of impact, sets the focus on where to make investments and aids in targeting intervention strategies and policies to decrease food losses along the supply chains.

To measure and monitor food losses along the supply chain countries can follow the main principles of the methodology, which will be explained in depth throughout the document:

1. Target a Food Loss Percentage that can be interpreted as the percentage of production that does not reach the retail stage. Focus is on 10 key commodities in 5 main groups.<sup>2</sup>
2. Measure Food Loss Percentages (FLP) and not total losses; use the guidelines to collect and estimate quantitative losses.
3. Achieve nationally representative loss percentages along the supply chain from post-harvest up to but not including retail<sup>3</sup>.

Steps to compiling the Index if the data exists:

1. Select Basket of Commodities and compile weights
2. Compile Food Loss Percentages<sup>4</sup>, starting from SDG reporting year 2015
3. Compare the Food Loss Percentage over time<sup>5</sup>
3. Report the percentage losses, converted to quantity in the Food Balance Sheets

One of the key inputs needed in the decision making process is the need for better data to drive innovation, encourage best practices and allocate resource to their best use. At the moment with 4.4% of loss data reported at the national level by a handful of countries, a global priority

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<sup>2</sup> Countries can monitor more than the 10 key commodities as resources allow, but at minimum 10 should be selected. The originally selected basket can be changed by countries. The default is the highest production value in each category.

<sup>3</sup> Harvest losses can also be included, though treated separately from losses in the rest of the value chain.

<sup>4</sup> These should be nationally representative estimates at minimum, countries may get more value from having these losses represented at subnational stages.

<sup>5</sup> For the baseline its recommended to survey 3 consecutive years and then measured again every 3 to 5 years after



is in improving the generation and objectively measured data. There are huge differences within countries (in supply chains, products, typologies of actors, stages of the value chain) that have been considered. And that countries may benefit greatly by having a disaggregated and sub-national information base, to help to identify where most impactful and most-efficient policy and interventions should be focused and are relevant for the country undertaking SDG 12.3.

### 1.1. Policy environment to estimating food losses for SDG monitoring

Historically, loss assessment studies have been associated with loss reduction/prevention programs. The Seventh Session of the United Nations General Assembly, meeting in 1975, set the goal of 50% reduction of post-harvest losses by 1985. Since then, there have been many pitfalls and challenges to obtaining reliable information about food losses. Supply chains often include a wide range of commodities with different measurement characteristics, many processes and chain stages as well as chain agents, which differ in efficiency depending on timing, geographic scope and response to shocks. They are notoriously complex to measure losses given these factors. The loss-data scarcity problem has been ongoing for several decades and one of the main limitations on effectively measuring losses have been in the costliness of data collection along complex and far-reaching supply chains. Therefore, the main known challenge for most countries will be in obtaining the food loss percentages, by commodity over time. FAO has developed an approach, which will be discussed and addressed in the cost-effective measurement guidelines.

The justification for the SDG target 12.3 in the global framework for many stakeholders in this process have been to decrease the economic and environmental burdens of loss and waste, while maintaining food and feed safety, in addition to decreasing food insecurity. Decreasing food losses is the result of several other key-policy objectives and not always a policy per se within itself. Focusing on measuring losses allows for countries to track the efficiency and performance of the food system, while taking into account many of these objectives across supply chains. The recommended approach is in providing a method and strategy to disaggregate from the global indicator, down to national, subnational and potentially further to the distributional aspects of the problem.

In the long-run, projections suggest that more production will be needed to meet the food, feed, fiber and fuel demands placed on agricultural systems. Decreasing food losses may alleviate some of these demands, especially when considering it from a food systems approach. This approach layers the quantitative measurement of food losses with the economic tradeoffs and incentives in markets, as well as policy important factors (qualitative, nutrition and environment) at a temporal and spatial frame that is appropriate. For example, in the short- and medium-run, increasing food availability in a local market may mean lower prices resulting in producers leaving the market, especially as producers and middlemen become more effective. High losses, especially off-farm/after-slaughter/post-landing, can indicate that the

markets have no ability to utilize surplus, and a lack of channels to alter/preserve the product to something that is more “shelf-stable” or can better endure distribution from farm to fork.

Many policies have been tried to correct market failures that result in losses, to varying degrees of success, and have included: extension services, farmer organizations, government support (e.g. public research and development, support programs at different stages, food safety services, etc.), marketing boards and government quota purchases/sales (which have been mostly phased out in recent years due to costs and questions of competitiveness and trade regulation). In addition, behavioral aspects of loss and waste may be driven by prices throughout the market supply chain. Dually, prices are closely related to quantity and quality and have their own temporal dimension to consider. As countries collect additional data, it will become apparent that there will likely be a minimum threshold in which losses are not socially or economically efficient to reduce below.

## 1.2. Approach to estimating food losses for SDG monitoring

In order to increase the information base for SDG measuring and monitoring, FAO has a two-pronged approach:

1) Improve the collection of data along the supply chain through nationally representative sampling and surveying, and other statistical tools, which are integrated into the national agricultural statistics systems. FAO advocates for a survey based and nationally representative collection of data, in order to ensure that estimates can be applied appropriately, but recognizes that the most cost-effective approach should be taken. To this end, FAO has produced guidelines for countries on the estimation of food losses along the supply chain.

2) Estimate model-based losses where data is not available in the short term and to model in interim data collection years. To this end, FAO developed a model that incorporates explanatory variables based in the literature to explain losses, which will add value for countries seeking to both decrease losses and focus on factors that make the greatest impacts. The model is described in brief in the section Model-based loss estimates and a more comprehensive working paper is being edited for publication.

In order support the data requirements, FAO developed a set of guidelines to develop food loss sample surveys, including sampling methodology and measurement. The first document “Guidelines on the measurement of harvest and post-harvest losses<sup>6</sup>” for grains was developed under the aegis of the Global Strategy to Improve Agricultural and Rural Statistics<sup>7</sup>. The guidelines have been field tested and are being used in three Sub-Saharan African countries to

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<sup>6</sup> GSARS and UNFAO, *Guidelines on the Measurement of Harvest and Post-Harvest Losses Recommendations on the Design of a Harvest and Post-Harvest Loss Statistics System for Food Grains (Cereals and Pulses)*.

<sup>7</sup> Global Strategy to Improve Agricultural and Rural Statistics, [www.gsars.org](http://www.gsars.org)

set new postharvest loss surveys. Additionally, three annexes covering on- and off-farm measurement in fruits and vegetables, milk and livestock products, and fish products are under preparation and being field tested in 2018<sup>8</sup>. These documents are referred throughout the document as “the Guidelines”.

In addition, FAO has been piloting how to incorporate existing food loss data, how to prioritize and target data collection efforts within a strategy working paper, which is still in draft form and is being generalized and expanded upon with country experiences. The document illustrates that countries will want to assess the critical loss points as primary step<sup>9</sup>. The document will further address how to incorporate existing information and data from disparate sources, in order to build an information system to measure and track losses at the national level. These sources include the administrative and sectoral data, expert opinion across various stages, and survey data from various data collection instruments. Both the guidelines and the strategy documents aim to improve the data in cost-effective ways.

## 2. Concepts and definitions

The first major challenge encountered in the process of measuring losses in the supply chain is the lack of an agreed international definition of food losses. The proposed definition builds on the revised “Definitional framework of food loss and waste” developed by FAO under the Save Food Initiative<sup>10</sup>, the international definitions used for agriculture statistics by FAO and feedback from experts during the process.

The FAO’s External Consultation on Food Losses and Waste<sup>11</sup> acknowledged the difference in the nuances and what is desired to be included in the concepts of Food Losses and Waste and what within these concepts are feasible, within resource constraints, to be measured in a statistically reliable and consistently. The ***Conceptual framework*** that strives for completeness and ***Operational framework*** which focuses on the viability of definitions to produce consistent measurement, given the known issues with the availability of data and measurement. The operational and conceptual frameworks will therefore differ.

Within the ***Conceptual framework*** the following definitions are used:

- **Food** – is any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has

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<sup>8</sup> Drafts of the annexes can be found at XX

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<sup>10</sup> FAO’s “Definitional framework of food loss and waste”: the first 2014 version is available on-line at [http://www.fao.org/fileadmin/user\\_upload/save-food/PDF/FLW\\_Definition\\_and\\_Scope\\_2014.pdf](http://www.fao.org/fileadmin/user_upload/save-food/PDF/FLW_Definition_and_Scope_2014.pdf), while the revised version dated October 2016 has not yet been published.

<sup>11</sup> An External Consultation on Food Losses and Waste was organized by FAO in September 2017 with 35 participants from countries, international agencies and the academia.

been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs<sup>12</sup>.

- **Food loss and waste (FLW)** – is the decrease in quantity or quality of food.
- **Quantitative food loss and waste** – is the decrease in mass of food.
- **Food loss (FL)** in the production to distribution segments of the Food Supply Chain is mainly caused by the functioning<sup>13</sup> of the food production and supply system or its institutional and legal framework.
- **Crop-livestock-fish product loss or Post-harvest loss** – All quantity losses (food and non-food) along the Food Supply Chain for all utilizations (food, feed, seed, other) up to but excluding the retail to consumption level.
- **Pre-harvest** constitutes the time frame between maturity and harvesting.
- **Harvest** refers to the act of separating the food material from the site of immediate growth or production.

Within the ***Operational framework***, the following concepts of loss and waste have been adopted for reasons of measurability and consistency with other statistical definitions:

- **Food losses** - *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 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. Losses include the commodity as a whole with its non-edible parts.*

- **Waste** occurs from retail to the final consumption/demand stages

The operational and conceptual definitions of food losses differ with respect to the exclusion of qualitative losses, the inclusion of non-edible parts, and to the limitation of the concept within set boundaries of the supply chain. Pre-harvest and harvest losses are excluded from the Global Food Loss Index but harvest losses can be covered at country level when available or relevant.

Furthermore based on these delineations the following definitions are considered:

- **Edible** refers to that element of food that a population of specific cultural or economic group traditionally consume
- **Harvest losses** occur during the harvesting process and may be due to, for example to shattering and shedding of the grain from the ears to the ground<sup>14</sup>.

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<sup>12</sup> Codex Alimentarius Commission, Procedural Manual, 2013

<sup>13</sup> To clarify, losses beyond a certain level is a failure of the system for many reasons, but are still a result of how the markets malfunction.

<sup>14</sup> In the expansion of the annexes to the Guidelines, harvest losses for other commodities can include those related to sorting and grading at the farm or its equivalent production site.

These operational definitions help in addressing issues from the sizable differences amongst countries in terms of data quality and data availability. Moreover:

- They ensure consistency with the definition of agricultural production used by the countries and by FAO within the Food Balance Sheet Framework (FBS), where agricultural production is net of harvest losses. The inclusion of harvest losses would require redefining production (as it would change yield calculations) and therefore alter the consistency and comparability of the dataset over time.
- They avoid double-counting of pre-harvest losses due to environmental disasters, which are captured by another SDG indicator (SDG 1.5).
- Inclusion of harvesting losses can be considered and handled without requiring the redefinition nor double counting commodities that are damaged from the environmental disasters.
- Harvest losses due to sorting and grading at the point of production are appropriately accounted for within the measurement guidelines. This will enable countries to measure the impact of contract farming and quality standards (at each stage of the supply chain on food losses and waste).
- Animal feed is never considered a loss, as the animals return to the food system.
- The FAO loss definitions require reporting on quantities that are removed or disappeared from the supply chain. The measurement guidelines recommend asking about the final destinations (e.g. landfilling, biofuels, etc.) because it may be policy relevant.
- Diversions to secondary value-added products that will eventually be consumed by humans (e.g. processed products (juice, sauce, etc.) in the food production chains) are not considered waste or losses in the FLI.

## 2.1. Supply chain and index boundaries

The scope and split of the two indicators are summarized in the simplified food chain in Figure 1, where the loss indicator will cover losses from the farm up to but not including the retail sector.

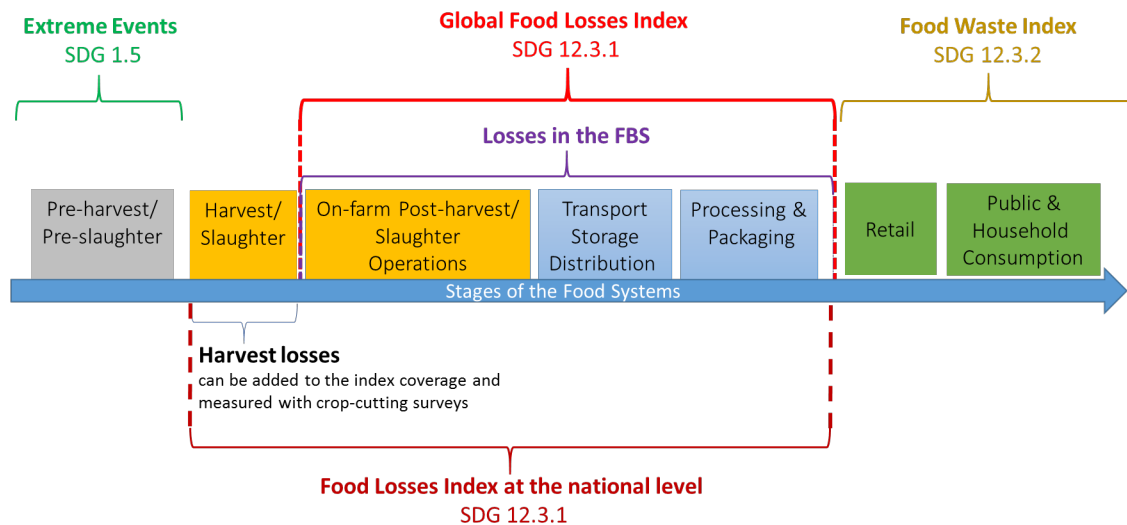


Figure 1. Boundaries of the food supply chain in the operational definition of the GFLI

The SDG target 12.3 relates the reduction of food losses and waste along the whole food chain to the overarching goal 12 for sustainable production and consumption. Food Losses and Waste indicators should therefore inform policies that can improve the efficiency of the value chain, change the behavior of the various actors to reduce waste or encourage a better use of food products and by-products. The indicator aims at measuring the structural losses along the value chain that can be impacted by such policies.

These policies cannot act on the occurrence of extreme events and natural disasters. Moreover, these events are unpredictable. In this light, pre-harvest losses that are due to extreme events and natural disasters should be covered by the SDG 1.5<sup>15</sup>. To include these losses in 12.3 would be double counting and make it more difficult to use both indicators appropriately.

The specific definitions of these stages are broken down by product type (Annex 1: Losses defined by stage and commodity group

) and can be found in the Guidelines for Measurement. Given the differences in each supply chain, expansion on these definitions can be found in their respective documents, but has been summarized by stage and commodity group in the Annex.

1. 15. SDG target 1.5: “by 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters”. Proposed indicator: “Losses from natural disasters, by climate and non-climate-related events (in US\$ and lives lost)”

2.

The set boundaries have some limitations.

Harvest losses occur after the commodities are mature, but that are not harvest due to economic or environmental factors or through poor management. It is known that the harvest can be a critical loss point for many countries and commodities but the difficulty in including harvest losses in the international indicator comes from the definition of agricultural production used by most countries and by FAO. For example, with respect to crops, “Crop production data refer to the actual harvested production from the field orchard or garden, excluding harvesting and threshing losses and that part of crop not harvested for any reason.”

To include of harvest losses in the GFLI we would need to harmonize the concept and data on agriculture production in all. This means that FAO would request that most countries change they survey method and introduce a break in the production data, including those countries for which the harvest is not a critical loss point. However, harvest losses can be integrated in the Food Loss Index scope if the reference quantities (i.e. production) are adjusted to include harvest losses, at the country level. At the present moment, information on losses by commodity are defined from post-harvest to retail, to be comparable to the definitions found in the Food Balance Sheet Methodology. Losses in agricultural production statistics have been historically reported net of harvest losses and will remain so, as to not impact comparability over time. However, within the scope of the index we can adjust to include these within the calculation. To reiterate, this can be done at country level, but will be excluded at international level to ensure comparability of results to the information that has been collected<sup>16</sup> for all countries.

Furthermore, within the measurement guideline annexes and their respective field tests, questions are being tested to see what or if data can be collected on commodities that would be otherwise left/discarded due to economic, selection/grading or other reasons. The causes of loss at the various stages do not specify intentionality, but are structured for a major set and open ended for any additional causes that agents along the supply chains wish to elaborate. Countries will be able to further investigate policy solutions after collecting the quantitative data that is lacking.

Other challenges in the boundaries are in the flows of goods in and out of stages or of the country over a single year. For example in Wholesale/Processing stages where commodities are imported and exported or storage, with withdraws over the year. Processed and semi-processed imported products become intermediate goods and mix with other commodities, or end up directly in the retail and consumer stages, both the mixed commodities and the finished-to-retail fall under the food waste indicator. For commodities that are processed into

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<sup>16</sup> Included in the measurement questionnaires for fruits and vegetables, is a question on the quantity of mature harvest left in the field to cover the debate on selection/grading decisions; with grains and pulses the measurement strategy is to use crop-cutting surveys.

derived commodities (e.g. wheat into flour), the losses inherent in the conversion are captured in a series of Technical Conversion Factors (TCF). The comparison of the TCFs across countries, will show inefficiencies in the structural losses in the processing practices of the country. Assessing losses in processing will be based on data for these TCFs, input quantities and output quantities, that is available through either the National Industrial Processing questionnaire, where available or from producer organizations within the country. For non-industrial processing along the value chain, within the measurement guidelines annex pilots, questions are being tested for different operations for various actors. The uncertainty at this stage revolves around mixed commodities<sup>17</sup> that are diverted from the next stage in food chain (retail) and would be considered as a waste.

Imports of primary commodities and their related losses must be included in the calculations both at the numerator (losses starting at the wholesale stage) and at the denominator for the stage at which the commodity enters/exits the market. However, given the current lack of data on where the losses occur along the supply chain, and as countries only report at the national level and not at subnational stages for the FBS, the loss percentages are applied to production plus net imports for import dependent countries, in modeling the percentage losses in their food system.

There were several challenges to including retail and consumer related waste within a single indicator.

The first challenge was in the wording of the SDG target that sets a quantitative goal at the retail and consumer level at -50% and leaves Post-harvest losses at an unspecified amount. It is unlikely that some supply chains will need to decrease post-harvest up to retail losses by 50% to be economically and socially optimal.

The second challenge was in policy, where consumer and retail waste is often behavioral and not structural, which will require more advocacy driven initiatives (e.g. date labeling, portion sizing, 'ugly fruit' consumption, etc.), whereas supply-side policies are often focused on investments within businesses (e.g. improved processing equipment) and structural aspects of the distribution networks, access to market information and logistics.

And within the measurement guidelines, it is being tested to measure quantities removed along the stages of the supply chain matched with the causes of loss at that stage and activity, to the end that the causes can be both structural and behavioral depending on what the country sets as the main causes they would like to measure.

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<sup>17</sup> This would be akin to knowing what percent of a pizza is wheat, tomato, meat, etc. and being able to back out how much was lost if 1000 tons of pizzas were lost. This is simpler to calculate as a volumetric measure and geared towards the waste indicator.



The third challenge is that the measurement of waste at the consumer and retail level are often discussed in terms of kilograms of mixed food, which include edible and inedible parts. Measuring loss quantities in kg per caput does not inform the relevant policies for supply chain actors and the indicator may be influenced more by population trends than by the structural improvements along the supply chain.

For these reasons FAO and the UNEP recommended to use two indicators to measure the two aspects of SDG target 12.3 to more effectively craft policies and to structure measurement.

## 2.2. Selection of commodities

Data coverage in terms of commodities is another major challenge even in countries that collect loss data. Based on the available literature, it is difficult to find loss estimates for many supply chains across all countries. Therefore, it was recommended that countries start with a more narrow set of key commodities, and if able build up their capacity at the national level to measure above and beyond those in the SDG Food Loss Indices. In the consultative process, many countries have commented that diverse diets and food security are key priorities related to this indicator. Therefore, the basket has a structured set of commodity headings covering many facets of a typical diet. More than one commodity per heading was included to capture a range of perishability as even within headings the levels of losses may vary.

The default selection criterion followed at international level to select the priority commodities and impute missing loss data and the related FLI is commodities ranking by value of production in within each country and commodity group. The default process is to:

- Compile value of production for every commodity
- Group commodities by category and rank them
- Select the top 2

The default selection process is based on the international dollar value of the commodity in the base year. At national level countries can use their own set of values or quantities and prices or use different policy based criteria, as long as the main headings are covered.

The index top 10 commodities by economic value are within the five main headings, with two commodities per heading (1. Cereals & Pulses, 2. Fruits & Vegetables, 3. Roots & Tubers and Oil-Bearing crops, 4. Animals Products, 5. Fish and Fish Products).

Countries may choose other commodities within these headings based on National priorities, but restricting them to two per heading will ensure better comparability and potentially better measurement across all countries. Two underlying assumptions to this selection process have been made:

1. Categories correspond to the basic food groups and dietary needs, so every country should have at least one priority commodity in each category.

2. Loss levels of the products within categories should be broadly similar, within countries, while average losses between categories will be systematically different. For example the variation of losses in fruits are higher than those in grains, but within grains losses may be similar. Countries are free to collect data and track losses for other commodity value chains, above and beyond what is required for the SDGs. To this end, a main heading 6 is available at country level only to cover any product not included in the first five headings (e.g. nuts or spices).

Once the basket is selected, for the GFLI and FLI, the selection is fixed at the global level to allow for comparison over time. However, since the SDG process is a country-driven process, the selection of the final baskets will be a key decision for those monitoring this indicator.

This solution guarantees some comparability at main heading level but gives flexibility to the countries at commodity level to ensure relevance of the basket. Commodities and groups are based on an international classification. FAO uses the Central Product Classification (CPC) Version 2.1<sup>18</sup> for its production statistics and in the Food Balance Sheets framework. Commodities are further aggregated into groups, which are further clustered into the main headings for the GFLI<sup>19</sup>. The full list can be found in the Annex 1: Losses defined by stage and commodity group.

Countries are free to choose different baskets that meet a variety of policy objectives internal to the country (or export driven) as long as the headings still have two commodities each. In addition, if countries want to look at the basket of goods with different commodities over time, the recommendation is to monitor additional commodities at the national level, so that the data may be available for such comparisons.

### 2.2.1. Changes in the basket over time

An analysis on FAOSTAT data has been carried out to assess the basket stability and validity over time. Over a 10 year period from 2004-06 to 2014-16, looking at value of production at fixed international dollar prices, 151 out of 189 countries would have altered the selection in at least one group. Most of these changes are one-off, where within a single year, the highest production quantities alternate but then reverts back to the original commodity chosen (e.g. corn-soybean rotations); or the switch in production is between similar products (e.g. almonds

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<sup>18</sup> <https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf>

<sup>19</sup> The CPC is a comprehensive classification of products into a system of categories that are both exhaustive and mutually exclusive. It is based on a set of internationally agreed concepts, definitions, principles and classification rules. The term “products” follows the SNA definition, i.e. all output of economic activities that can be the object of domestic or international transactions or that can be entered into stocks, including transportable goods, non-transportable goods, services and other products. The CPC is highly compatible with the HS and ISIC and its custodian is the UNSD. For more information, see, <http://gsars.org/wp-content/uploads/2015/12/Guidelines-for-Int-Classifications-on-Agricultural-Statistics-web.pdf>

and walnuts). The basket selection for Fruits & Vegetables had the most changes with 40% of the countries with at least one replacement over the period.

### 2.2.2. Comparability

The purchasing power parities (PPP's) as a framework for international commodity based comparisons based on representative commodities, was considered as the good practice of what may be possible<sup>20</sup>. The ICP framework provides the structure for using commodity headings as a means of aggregating similar commodities in order to do global comparisons.

With respect to comparing losses, the proposal is to ensure coverage at the commodities group level, because it is impossible to set a global core basket that is policy relevant for all countries. The objective is to move the comparability to a higher level, but while the ICP groups countries for bilateral comparison, the method here is grouping commodities. Bilateral comparisons will still be possible because the basket is based on the CPC.

## 3. Global Food Loss Index (GFLI)

To monitor progress against Target 12.3, FAO has developed the Global Food Loss Index (GFLI). The purpose of the index is to allow for policy makers to look at the positive and negative trends in food loss over time, with a base year of 2015, averaged from 2014-2016<sup>21</sup>. Analyzing the trend (versus the level) helps monitoring the food supply system in order to improve its efficiency against food losses.

The base period in the proposal has been set to 2015, which is the beginning of the SDG process and has been set by the IAEG-SDG as the initial reporting year. The final decision on the base year rests with the IAEG-SDG, which will not affect the methodology. A common base period is needed to be able to compile the GFLI and for comparison purposes. Food losses for many countries will have to be estimated or back-casted to 2015, as they will not have had a baseline survey in 2015. However, since the underlying data for losses has been a part of the data collection in the Food Balance Sheets, preliminary estimates of losses have been validated through this dataset. Although the methodology for measurement will be relatively new to countries, especially in non-grain commodities, the long-term objective is that the improvements in the data collection will improve the underlying knowledge in all utilizations in the FBS framework, which will go beyond the timeframe of the SDGs.

The Global Food Loss Index (GFLI) is the aggregation of country-level Food Loss Indices (FLI). While the aggregated index is relevant for global and international monitoring, countries will likely gain the most value from the disaggregated Food Loss Index (FLI) at the sub-national level by geographic area or agro-ecological zone, points of the value chain (farm, transport, markets,

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<sup>20</sup> ICP, "Purchasing Power Parity Index."

<sup>21</sup> The base period has been set to 2005 during methodological development. It will be moved to 2015 as soon as 2016 the methodology has been approved.

processors), and distributive economic sectors (small-holders or traditional sector versus large and commercial farms/firms) at each stage.

Section 3.1 will provide a step by step compilation of the Food Loss Index and its aggregation into a regional or global index for SDG reporting purposes.

### 3.1. Food Loss Index (FLI) and Food Loss Percentage at country level

The Food Loss Index has a traditional fixed-base formula comparing percentage losses of country (i) in the current period (t) to percentage losses in the base period (t<sub>0</sub>) for a basket of commodities, using value of production plus imports (q<sub>ij</sub>t<sub>0</sub> \* p<sub>jt</sub><sub>0</sub>) in the base period as the weights. The index is a composite of commodities (j) that are key in national agricultural production or food systems, including crops, livestock, and fisheries. It tracks losses as a percentage of total supply (l<sub>ijt</sub>), in order to exclude the impact of production variability.

$$FLI_{it} = \frac{\sum_j l_{ijt} * (q_{ijt_0} * p_{jt_0})}{\sum_j l_{ij0} * (q_{ijt_0} * p_{jt_0})} * 100 \tag{1}$$

To ensure comparability at international level, losses are aggregated using fixed value of production at international dollar prices in the base period, i.e. using the same prices for all countries<sup>22</sup>. At national level, countries can use national price and production data.

The loss percentages which compile the national indices, and are the most critical pieces of information, will be the nationally representative loss percentage for each commodity along the supply chain. These losses are built from subnational stages and aggregated to the national number. The strategy and measurement of compiling these loss percentages will be found in later sections of this document as well as, in the strategy for combining and measuring losses are covered in the **“Strategy for Measurement of Post-Harvest Food Losses”**, the *FAO-Global Strategy “Guidelines on the measurement of harvest and post-harvest losses: Recommendations on the design of a harvest and post-harvest loss statistics system for food grains (cereals and pulses)”*<sup>23</sup> and the *Annexes on Fruits and Vegetables; Animal and Animal products (Milk, Meat and Eggs); and Fish and Fish Products*.

The FLI at the country level will be compiled in three steps illustrated below.

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<sup>22</sup> International dollar prices are regularly compiled by the FAO for the calculation of its Agricultural Production Index Number using the Geary-Khamis method. See Rao, *Inter-Country Comparison of Agricultural Output and Productivity*.

The Geary-Khamis method for establishing international prices was used up to the late 1980’s for GDP comparison in the International Comparison Program. It consists of a system of simultaneous equations which produce a set of international average prices converted into a common currency, traditionally the “international dollar”, using purchasing power parities endogenously obtained instead of exchange rates.

<sup>23</sup> GSARS and UNFAO, *Guidelines on the Measurement of Harvest and Post-Harvest Losses Recommendations on the Design of a Harvest and Post-Harvest Loss Statistics System for Food Grains (Cereals and Pulses)*.

### 3.1.1. Step 1: Compile percentage losses of each commodity $l_{ijt}$

The loss percentages  $l_{ijt}$  by country (i), commodity (j) and year (t) are the first variable to be obtained for the indicator. Losses can be either measured directly through representative sample surveys along the supply chain or can be modeled through the methodology provided by FAO.

Loss percentages are the final output of the whole data collection effort and the central piece of the methodology. Data collection, aggregation and compilation of loss data will be further developed in the paper.

### 3.1.2. Step 2: Compile the Food Loss Percentage of a country (FLP)

The Food Loss Percentage is the weighted average of all the commodities loss percentages in a given country, where the weights are equal to the commodities value of production.

The Food Loss Percentage (FLP) for a country (i), in a year (t) is defined as follows:

$$FLP_{it} = \frac{\sum_j l_{ijt} * (q_{ijt_0} * p_{jt_0})}{\sum_j (q_{ijt_0} * p_{jt_0})} \quad (2)$$

Where:

$l_{ijt}$  is the loss percentage (estimated or observed)

i = country, j = commodity, t = year

$t_0$  is the base year (set at 2005 for the moment)

$q_{ijt_0}$  is the production plus import quantities by country, commodity in the base period

$p_{jt_0}$  is the international dollar price by commodity for the base period

The FLP gives the average level of losses and will help countries assessing the magnitude of the problem relative to other countries or the international context.

The set quantities and prices are extracted from FAOSTAT<sup>24</sup> and are based on officially reported data by the countries to the FAO using the international Central Product Classification (CPC) Version 2.1<sup>25</sup>.

### 3.1.3. Step 3: Compile the FLI as the ratio between two Food Loss Percentages

The country-level indices (FLI), are simply equal to the ratio of the Food Loss Percentage in the current period and the FLP in the base period multiplied by 100:

$$FLI_{it} = \frac{FLP_{it}}{FLP_{it_0}} * 100 \quad (3)$$

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<sup>24</sup> <http://www.fao.org/faostat/en/#home>

<sup>25</sup> <https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf>

Where:

$FLP_{it}$  is the country's Food Loss Percentage

Formulas (5) and (7) are equivalent and produce the same results. While the former is formally more correct, the latter formula is more practical.

### 3.2. Global Food Loss Index formula and compilation: aggregating countries' FLI

Countries' Food Loss Indices (FLI) can be aggregated at global and regional level into the Global Food Loss Index, GFLI, and Regional Food Loss Index (RFLI) respectively for international monitoring.

The GFLI is a weighted average of the countries' FLI using weights equal to the countries' total value of agricultural production in the base period. The formula is:

$$GFLI_t = \frac{\sum_{i=1}^G FLI_{it} * w_i}{\sum_{i=1}^G w_i} * 100 \quad (4)$$

Where:

$w_i$  is the total value of agricultural production of country i at international dollar prices in the base period.

Concurrently, a Food Loss Percentage (FLP) can be aggregated into a Global Food Loss Percentage (GFLP) or a regional (RFLP) percentage, using the same formula and weights:

$$GFLP_t = \frac{\sum_{i=1}^G FLP_{it} * w_i}{\sum_{i=1}^G w_i} \quad (5)$$

Where:

$w_i$  is the total value of agricultural production of country i at international dollar prices in the base period.

The same formulae apply when compiling regional indices or Food Loss Percentages.

The same formulae apply at the regional level to compile the Regional Food Loss Index (RFLI) and Regional Food Loss Percentage (RFLP).

#### 3.2.1. Aggregating losses along the supply chain

The objective of the FLI is to estimate losses at the national level. In order to standardize losses along the supply chain and aggregate them upwards, a simplified process was used<sup>26</sup>. The

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<sup>26</sup> It was found that in some of the post-harvest literature, the aggregation of the stages was done through adding percentages instead of applying the percentages to what would be remaining in the supply chain at the stage. This is not the correct way to aggregate percentages.

process assumes that *measured* losses at each point are independent of each other and works in the following way:

- At each stage in the supply chain, the model takes the national average percentage for each crop and year for which there are multiple estimates
- The percentage along the stages in the supply chain are applied to a reference quantity and subtracted from the remainder of the previous stage’s amount. This enables to take into account imports at the various stages of the supply chain (primary products at wholesale level, semi-processed products for further processing, etc.).
- At the end of the supply chain the remainder is then divided by the original reference quantity to convert back to a percentage.

|  |                                 |                  |                |                |                   |
|--|---------------------------------|------------------|----------------|----------------|-------------------|
| Starting Amount - Agriculture production       | 1000                            |                  |                |                |                   |
| Average Losses (%)                             | Farm<br>7.3                     | Transport<br>1.5 | Storage<br>7.7 | Wholesale<br>0 | Processing<br>3.5 |
| Amount Lost                                    | 73                              | 13.905           | 70.308         | 0              | 29.497            |
| Amount Remaining                               | 927                             | 913.095          | 842.787        | 842.787        | 813.289           |
| % of total supply still in the market          | $81.3\% = (813.289/1000) * 100$ |                  |                |                |                   |
| % lost from farm to (but not including) retail | $18.7\% = (1-0.813)*100$        |                  |                |                |                   |

Table 1. Aggregation of Maize Loss percentages along the supply chain

The 18.7% in the table would then be the reported quantity for that supply chain, for the country in the given year. This percentage would be applied to the production plus imports to calculate the quantity of losses to be reported in the Food Balance Sheets. The loss percentage would also be used in the Food Loss Index for the country, an applied to the base weights and then can be compared to the loss percentages times the weights in the base year to analyze the trends over time.

### 3.2.2. Accounting for Imports and Exports

Imports and exports flow in and out of countries at different stages of the supply chain. In many countries, imports enter in the wholesale and processing stages as value-added products and as fully finished products in the retail and consumer markets (which are covered under the Food Waste Index). Exports alternatively leave after the producer stage, sometimes without being domestically stored or entering the wholesale market.

Theoretically, if there are losses, accounting for those within the stages would mean that each stage would have a different denominator to account for the increase/decrease in volume available. And as data collection improves, this may be possible. However, at the moment,

losses are often reported only at the country level, with the dynamics of where imports and exports occur in a value chain unknown. Additionally, several countries have imports that far exceed their production (island and small nations, especially) and losses are still apparent in their domestic markets.

Therefore, the decision was made to apply the loss percentages over production plus imports of a country for import-dependent countries, minimizing the double counting and the application of losses from the exporting country’s supply chain until better data allows for a more accurate accounting.

### 3.3. Interpretation

A country’s Food Loss Percentage (FLP) can be interpreted as the average percentage of supply that does not reach the retail stage. The FLP positions a country’s food system efficiency and summarizes the magnitude of the problem. For example an FLP of 18 in the base period means that 18% of the key commodities is lost along the supply chain and does not reach the retail stage.

The FLI shows how much losses move from the baseline value equal to 100 in the base year, hence it reveal trends in efficiency over time. In our example, if the Food Loss Percentage changes from 20% in the base period (set at 100) to 15% in the current period, the index will return a value of 75 in the current year meaning that there has been an efficiency gain of 25 percentage points in the food system and a higher share of total supply reaches the retail stage undamaged.

The interpretation of the GLFI is similar to the country FLI, but for the meaning of the weights, which are equal to countries’ value of agricultural production, including animal and fish, i.e. the size of countries’ agriculture sectors. A GFLI lower than 100 indicates the structural food losses in the key commodities from production to retail are decreasing at the global level. The trends can differ between countries, with some FLI’s increasing and other decreasing, with the latter outweighing the former. Both indicators, the GFLI and GFLP are relevant as they inform both the trend and the level of percentage losses (see Figure 2).

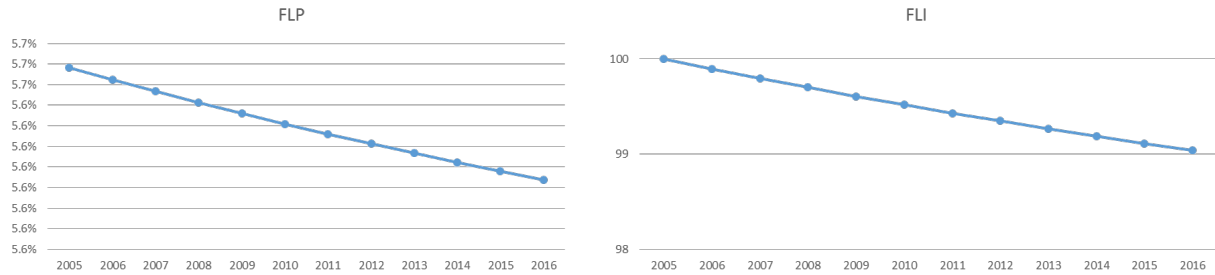


Figure 2. The Food Loss Percentage (FLP) and the Food Loss Index (FLI)



It must be reminded that the known limitations of using fixed weights will apply to the FLI. With weights equal to the value of production for the country in question, the highest valued commodity in the baskets will have the highest impact on the index over time even if the country changes its production pattern and the said commodity's importance decreases.

The difference in the FLI and GFLI dynamics is that a country FLI will be influenced by the trend of its most important commodity while the global GFLI will be influenced by the trend in the largest country in the aggregate (or the one with the largest agricultural sector).

### 3.4. Representing losses along the supply chain

To represent how to move from the Global Food Loss Index to the Food Loss Index and to the commodity baskets and stages, the following is considered. The Countries will set a Basket of commodities can be monitored through the FLI.

Each of these product loss percentages can be broken into loss percentages by stage of the value chain. It is expected that loss percentages at each stage of the segmented value chain are nationally representative, but that there are underlying distributions of different actors at each stage. The complexity of this problem requires it to be broken into simpler parts and then aggregated.



Figure 3. General Supply Chain

Each stage is going to have losses that will either be critical and large relative to the amount of losses moving along the chain, which can be measured or calculated, or that will be of lesser importance and kept with a placeholder based on expert opinion and other assessments. The best method for estimating losses and ensuring comparability across stages and time is a sample survey using objective measurement.

The losses by stage will be estimated for the different commodities and fed into the information system to monitor trends and levels. It is understood that some countries may only be able to get to an estimates loss percentage for each commodity chain, but as data collection efforts often happen at lower levels (e.g. through the annual farm surveys) a method was needed to feed the data upwards to the country's Food Loss Percentage, and then into the Global Food Loss percentage (Figure 4). These Food Loss Percentages can then be compiled into the Food Loss Index (Figure 5)

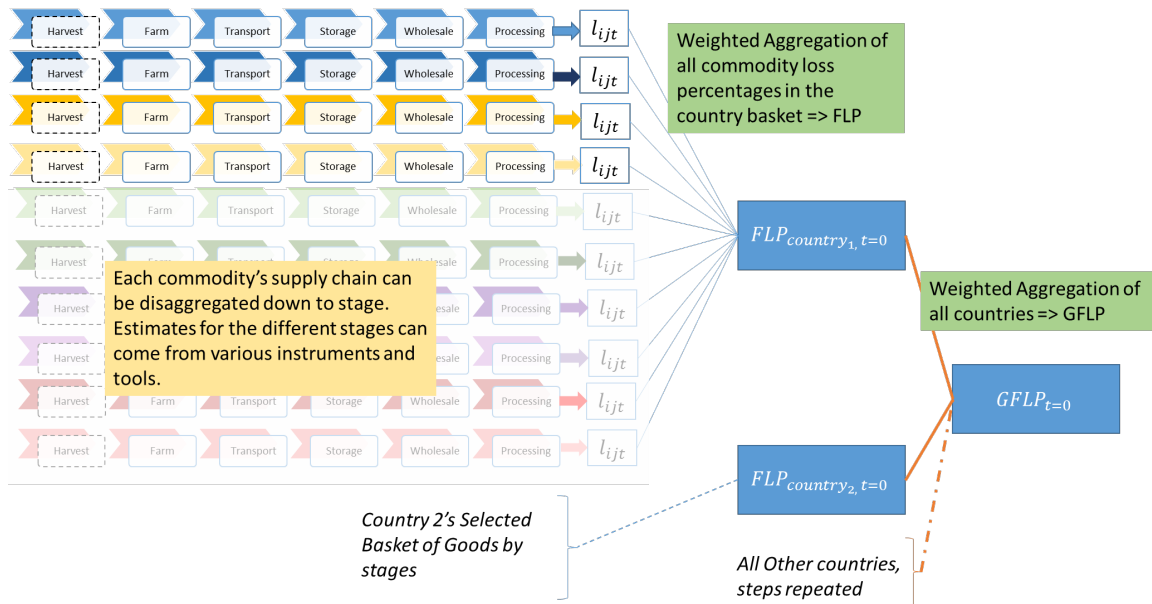


Figure 4. Food Loss Stages by type of commodity within the commodity baskets, for an example country for one year

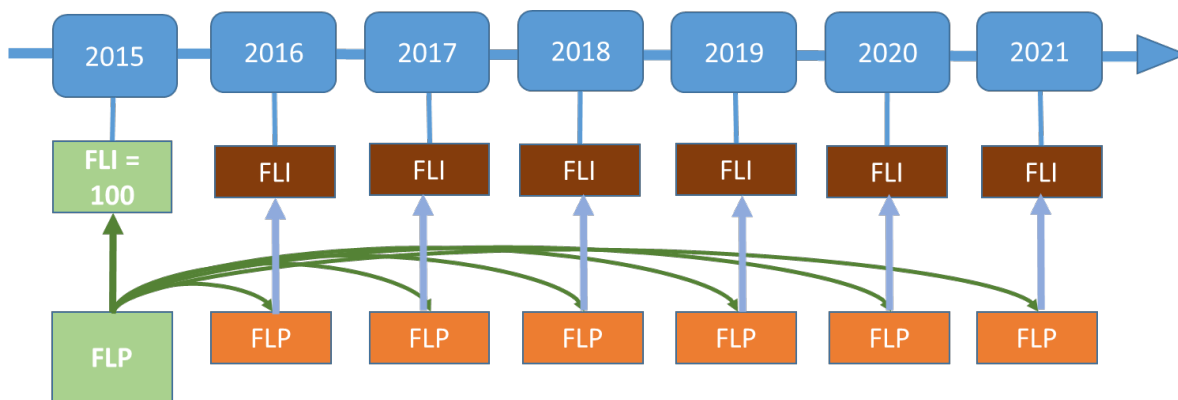


Figure 5. Food Loss index from the Food Loss Percentages

Several data collection instruments will be needed to cover all the stages in the supply chain. Some of them can cover multiple commodities, such as the agricultural surveys or surveys at the wholesale markets. However, in order to get into the policy objectives that focus on specific actors of the value chains, a further disaggregation into the strata at each stage will need to occur (e.g. size of producer or type of production system). This particular aspect is covered more in depth in the Data Collection Strategy Working Paper.

### 3.5. Weights

Although there has been significant discussion, the chosen weights are in terms of the commodities' economic value of production on the assumption markets operate efficiently in valuing the commodities importance. Prices will not reflect market failures (e.g. lack of access,

price distortions, etc.) but countries can work towards remedying these market failures and the impacts of which can be measured tangibly in percentage of losses across the commodities. Additionally, the index will not capture qualitative or economic losses, nor losses due to low market prices, which again be taken into consideration through additional analysis and estimation.

While there are known biases in utilizing economic weights, it may be the least biased of the potential aggregation methods and provide a context for the cost-effectiveness of intervention strategies. For example, in the Global Food Loss Index, countries with larger production shares will weigh more heavily than those with lower production. More importantly, within the country, the key to adjusting this bias is in the selection of the commodity baskets. Aggregating quantities without a weight would also bias towards potentially less useful commodities for food security, like watermelon or beef.

The weights for the FLI are the value of the commodities baskets in international dollar terms in the reference year. The weights for the GFLI reflect the economic importance the country's overall agricultural value, expressed in international dollar terms, relative to the rest of the world.

### 3.6. Compiling loss percentages

The focus of the indicator is on the loss percentages for each commodity in the basket. This was based on the assumption that percentages will help isolate the signal and not the noise, as production varies from year to year and total losses will vary with total production, while long-term loss trends will be relatively stable.

This is especially visible when countries apply a constant loss factor based on expert opinion to estimate losses. In the anonymized example below, (Figure 6) wheat losses were set at flat 15% of supply across all years yet total losses fluctuate over time in line with production. Carry-over factors occur in the dataset for the Food Balance Sheets when new data collection or modeling is not applied.

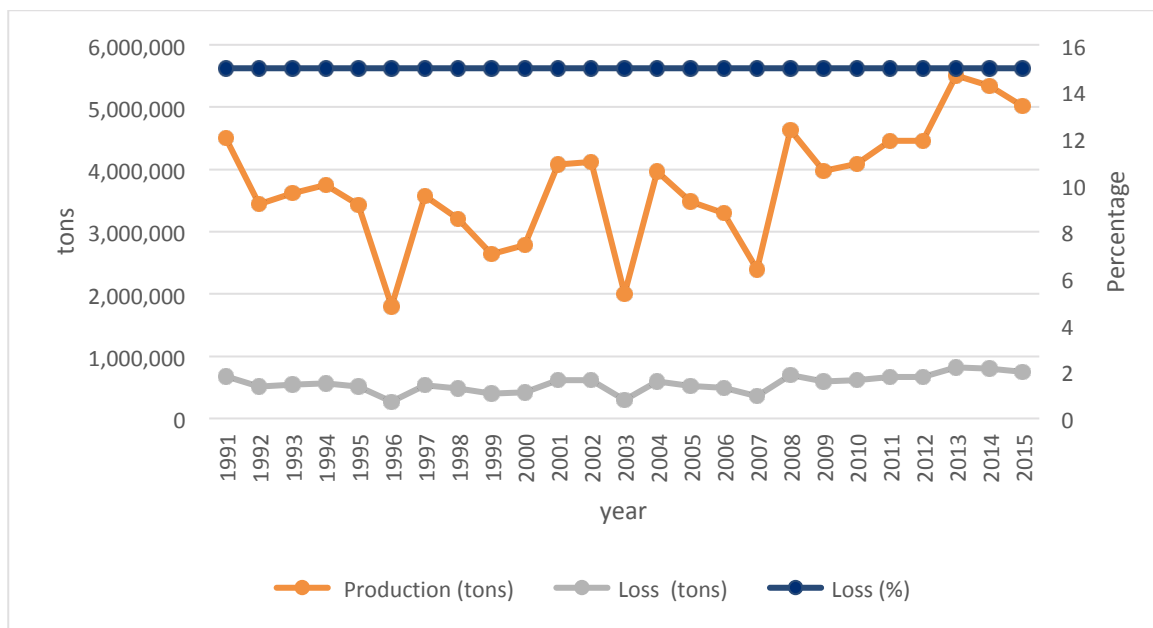


Figure 6. Wheat production and losses estimated applying constant losses of 15% factor

### 3.7. Two-Pronged Approach to Estimating Losses

Several sources of data can be used to compile the loss percentages at country level. Given the complexities of supply chains and the challenges in measuring losses across all dimensions of the problem, a strategy for prioritizing data collection efforts is needed. FAO has a two-pronged approach: 1) increase data availability and quality using sample surveys and other statistical tools; 2) impute losses for non-reporting countries using an estimation model.

There is no single ideal method of collecting loss data for all commodities and countries in a cost-effective way. Therefore, a wide range of instruments is needed to address this challenge. Several sources of data can be used and different data collection methods should be combined to collect the losses percentages that feed into the indices. These can include:

- Preliminary assessments to identify the critical loss points
- Full-sample surveys to construct national loss estimates by crops, that can be used as a benchmark
- Experimental designs to go in-depth into a specific aspect
- Qualitative approaches (e.g. focus groups) to better understand the socio-economic dynamics underpinning post-harvest management practices
- Modelling to improve the quality of the estimates (e.g. correcting declarative bias) and their efficiency, by allowing to reduce sample sizes or by providing model-based estimates between two survey rounds

The strategy for combining tools and measuring losses are covered in the “Strategy for Measurement of Post-Harvest Food Losses”, in the Guidelines. Moreover, FAO can provide technical assistance in improving the collection of data.

In principle, nationally representative loss data can be obtained with nation-wide sample surveys at all the stages of the value chain. This would mean to carry out loss surveys or add a loss module in the surveys at the farm, storage, transportation, packaging and processing as well as wholesale levels, or to carry out comprehensive supply chain surveys for few commodities. These solutions can be afforded by few countries only with high statistical capacity and a strong political will to address the issue.

In practice, it is necessary to focus data collection efforts and have first a very good understanding of the relevant value chains. This is done through Food Loss Assessment studies that identify the critical loss points in the food systems and the main causes for losses.

Information on crop/commodity agronomic practices as well as on the natural environment are also important, and can be utilized for stratification purposes or to improve the sample design.

### 3.7.1. Collecting nationally representative loss data

The above stated guidelines recommend applicable measurement methods in the context of developing countries, ensuring statistical soundness. They aim to strike a balance between precision and accuracy as well as cost and applicability while prioritizing data collection needs and requirements.

They provide harmonized definitions and concepts on food losses, identify relevant measurement methods and approaches, with a focus on those able to generate statistically reliable results, and recommend coherent and adapted measurement framework. A base principle is that there is no ideal method, but the choice depends on:

- the purpose of the measure preliminary estimate for quick assessment, national figure for policy purposes, etc.;
- available resources (financial, human, technical, time);
- Prior experience in loss assessments.

Within this, the guidelines help countries to prioritize on which crops, which segment of the value chain (on/off-farm, etc.) are important and which method provides reliable results for crops and segments.

The focus is on sample surveys for data collection because they provide statistically representative and comparable estimates. Moreover, the farm is a critical loss point in many countries and most of the countries already have farm surveys, to which a PHL module can be anchored for the sake of cost-efficiency, hence a strong focus is given to on-farm measurements. However, the stage by stage general recommendations are as follows:

Table 2. Recommended measurement tools by stage of the value chain

| Stage      | Recommendation  |
|------------|---|
| Farm       | <p>Harvest losses - Crop-cutting surveys</p> <ul style="list-style-type: none"> <li>○ Different yield, different definition of production</li> </ul> <p>Post-harvest losses – Sample surveys</p> <ul style="list-style-type: none"> <li>○ Relevant when there are very many small actors</li> <li>○ May cover on-farm storage, on farm transportation</li> <li>○ Can be complemented by experimental design or two-stage sampling on farm practices</li> </ul> <p>Post-harvest losses – complete enumeration</p> <ul style="list-style-type: none"> <li>○ Large commercial farms that keep accounting records (few)</li> </ul>  |
| Storage    | <ul style="list-style-type: none"> <li>• Losses and quantities stored</li> <li>• Model or experimental design <ul style="list-style-type: none"> <li>○ Inventory of storage facilities with their characteristics</li> <li>○ Controlled experiment of the various products, length and storage conditions</li> </ul> </li> </ul> <p>Administrative data</p> <ul style="list-style-type: none"> <li>○ Very large storage facilities</li> <li>○ Accurate accounts and records</li> </ul> <p>Farm sample survey (on-farm storage)</p> <ul style="list-style-type: none"> <li>○ Smallholder farms (large population, small quantities)</li> </ul> <p>Auxiliary data: Administrative data</p> <ul style="list-style-type: none"> <li>○ Weather at harvest</li> <li>○ Monthly Prices</li> </ul> |
| Transport  | <p>Losses and quantities: Sample survey of the trucks</p> <ul style="list-style-type: none"> <li>○ Measuring a sample of product at destination</li> </ul>  |
| Wholesale  | <p>Agreement with the private sector</p> <ul style="list-style-type: none"> <li>○ Quantities sold through the market, discarded product</li> <li>○ Sample or traders in the wholesale markets</li> </ul>  |
| Processing | <p>Agreement with the private sector or through the producer associations.</p> <ul style="list-style-type: none"> <li>○ Companies accounting records</li> <li>○ Complete enumeration or experimental design</li> </ul> <p>Additional data can come from existing National Industry Processing questionnaires to ascertain technical conversion factors, input and output quantities.</p>  |

### 3.7.1.1. Data collection frequency

To establish a baseline, the Guidelines recommend carrying out two or three consecutive comprehensive PHL surveys to establish a first solid set of preliminary estimates. Indeed, estimates limited to a single year have a higher risk of being biased because of the occurrence of specific events (e.g. that are weather-related), as compared to estimates based on two- or three-year averages.

Regarding frequency, the Guidelines on PHL do not recommended a complete loss survey every year, as loss ratios by activities tend to be stable, from one year to the next under normal conditions. Therefore, the recommended approach is to survey every three to five years, with lighter surveys in between based on declarations.

### 3.7.2. Model-based loss estimates

The second best solution in the absence of data is using a model to **estimate losses** within the framework of the Food Balance Sheets. To restate the approach of FAO is that the two-pronged approach emphasizes data collection and it should be prioritized over using the model based approaches. However, as countries are recommended to collect data every 3 to 5 years, a model for the intervening years will be necessary at a minimum to estimate the potential impacts of different policies. At the global level, given that only 4.4% of countries are reporting losses, a model for estimating the remaining data points is required.

The FAO has developed a loss imputation model to support the initial estimates of loss percentages by commodity and country for the GFLI and FBS purposes. Three successive attempts have been made since 2014 to improve on the underlying methods of estimations. This section will briefly illustrate the random effects model developed in 2017<sup>27</sup>. The model estimates at the country level first, addressing trends in the data and carryover factors that may have been reported by countries and then estimates the remaining observations at the global level, both applying the same methodology and principles laid out herein.

As previously stated, the reported data in the SUA/FBS database is insufficient to produce reliable estimates without incorporating external information. The loss percentage data available has been supplemented with information gathered from 300+ publications and reports (from academic institutions, international organizations such as the World Bank, GIZ, FAO, IFPRI, and other sources). Although there is a lot of variability in the measurement of these sources, they provide additional information on the causal factors for various stages along the supply chain.

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<sup>27</sup> The methodology for the loss model can be found in the FAO Working Paper, "*Imputing Food Loss Percentages In The Absence Of Data At The Global Level*", to be published soon

The underlying dataset will be made available on the FLW Community of Practice website, disaggregated and with data points above what was used in the modeling effort<sup>28</sup>. The model further uses a set of explanatory variables based on the factors found across the literature for post-harvest losses at the appropriate geographic scope (national, yearly) and where the data was available.

The random effects model imputes losses by clustered commodity groups, as the primary assumption is that losses will be similar for products within the same heading (e.g. losses for grains will be more similar amongst its subcategories than to fruits and vegetables). These clusters are based on the same classifications used to select the commodities baskets and weights<sup>29</sup>. The underlying assumption is that, although losses may be correlated within a group or country, the causation of losses is based on structural and explanatory variables. These variables will be different for each group and will not be comparable in magnitude. However, in several cases there are common elements across the estimation.

$$y_{ijt} = \alpha + x_{ijt}^T \beta + z_{ij}^T \gamma + u_{ijt} \quad (1)$$

where:

$y_{ijt}$  is the percentage of food losses for the country  $i$ , for a given commodity,  $j$ , at time  $t$

$x_{ijt}^T$  is the  $k$ -dimensional row vector of time and commodity varying explanatory variables

$z_{ij}^T$  is a  $M$ -dimensional row vector of time-invariant dummy variables based on the indices  $i, j$

$u_{ijt}$  is the idiosyncratic error term

$\alpha$  is the intercept

The model was run for all countries that have loss data in each of the product headings, adjusting for country based differences (e.g. losses in wheat in African Countries can be higher than those found in Canada, so a country-level adjustment is estimated within the model).

For countries that never reported on losses and for which no study is available in the literature, losses were estimated at the product heading level. The consequences in terms of outputs will be illustrated in next section.

Model-based estimates are the second prong in FAO's approach to compiling the FLI at international level in the absence of data. Countries may adopt this approach and adjust the FAO model structure to improve the output – for example by changing explanatory variables or improving the underlying datasets.

Additionally, as the final loss data is an aggregation along the supply chain – the modelling framework can be applied at the various stages to estimate losses prior to this aggregation.

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<sup>28</sup> <http://www.fao.org/food-loss-reduction/en/>

<sup>29</sup> UNFAO, "Definition and Classification of Commodities."



### 3.7.3. Loss estimates from Supply Utilization Accounts or Commodity Balance Sheets

The primary data source that FAO used to estimate the GFLI are loss data collected through its Annual **Agriculture Production Questionnaires** to compile the Supply Utilization Accounts/Food Balance Sheets.

Many countries compile Supply Utilization Accounts (SUA) or Commodity Balance Sheets<sup>30</sup> of selected products to monitor and analyze food supply and its uses, which are ideally based on accurate statistical and administrative sources. One product utilization in the SUA equation is the losses of the product, i.e. those quantities in primary equivalent that do not reach the retail stage. In the absence of survey data, loss quantities are estimated in the SUA framework and validated by a Technical Working Group or other institution responsible for the results. The SUA/FBS are therefore a unique source of validated estimates at the country level in the absence of objective data sources.

Losses in the SUA's are expressed in total quantities and are converted to loss percentages using the total supply. The SUA/FBS conceptual framework covers several stages of the value chain from the farm up to but not including the retail level (i.e. farm, storage, transportation, wholesale marketing and processing). Hence the estimated losses will apply to the same tracts of the value chain. In the SUA equations supply is equal to demand, and elements can be inter-related in many ways. In general, the balancing equates the sum of the supply elements:

- Opening stocks + production + imports ( 2 )

With the sum of the utilization elements:

- Exports + feed + seed + loss + food + tourism consumption + industrial utilization + closing stocks. ( 3 )

The reported data accounts for a small percentage or the data needs in terms of estimating the loss percentages: only 23 countries out of 185 reported on losses in 2016 for one commodity or more and only 4.4% of loss factors in the SUA/FBS database are officially reported, all others being estimated.

A preliminary analysis shows that losses in FAO's SUA/FBS database are lower than those reported in the scientific literature (Table 3 and Table 4). The explanation is many-fold. On the one hand, case studies and experiments are carried out where losses are reputed problematic. The results will therefore be higher than the national average. On the other hand, the SUA suffer from under-reporting by countries, which set loss to nil even on high perishable products

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<sup>30</sup> UNFAO, "Supply Utilization Accounts and Food Balance Sheets."

in the absence of information, and from under-estimation in interview-based surveys<sup>31</sup>. An increase in the loss level must be therefore expected with the improvement of available data.

Table 3. Loss percentages from the Food Balance Sheets, median and quartile values

| COMMODITY GROUPS                          | N. OF RECORDS | Percentage Loss (by Quartile) |      |      |
|---|---------------|-------------------------------|------|------|
|   |               | 25%                           | 50%  | 75%  |
| CEREALS & PULSES                          | 2066          | 1                             | 3    | 8    |
| FRUITS & VEGETABLES                       | 1603          | 4                             | 13.5 | 26.5 |
| ROOTS, TUBERS & OIL-BEARING CROPS         | 890           | 2.5                           | 4.5  | 10   |
| ANIMALS PRODUCTS & FISH AND FISH PRODUCTS | 425           | 0                             | 1    | 1    |

Table 4. Loss percentages from the Literature, median and quartile values

| COMMODITY GROUPS                          | N. OF RECORDS | Percentage Loss (by Quartile) |     |      |
|---|---------------|-------------------------------|-----|------|
|   |               | 25%                           | 50% | 75%  |
| CEREALS & PULSES                          | 718           | 2.0                           | 4.7 | 10.4 |
| FRUITS & VEGETABLES                       | 711           | 2.6                           | 7.5 | 16.1 |
| ROOTS, TUBERS & OIL-BEARING CROPS         | 236           | 0.3                           | 2.5 | 10.6 |
| ANIMALS PRODUCTS & FISH AND FISH PRODUCTS | 30            | 0.5                           | 3.4 | 11.8 |

#### 4. Global Food Loss Index preliminary results

This sections shows some preliminary output of the model and GFLI calculations. With all their limitations, due to the very limited data availability, these results show that the model and the related index produce acceptable estimates.

The food loss imputation model has been applied to the FAO's SUA/FBS database to produce loss factors for all countries and simulate the calculation of the Global Food Loss Index with a base period of 2004-2006 (centered on 2005). The index is an aggregation of all countries' Food Loss Indices based on each country's top 10 commodities. The commodities that are included in the commodity baskets by country have been aggregated and can be found in Annex2.

The following trend can be observed. Starting from a value of 100 in the base year (2005), the index has decreased to a level of 95.4 in 2014, meaning a 6.6% decrease in post-harvest losses has been accomplished in comparison with the baseline.

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<sup>31</sup> A systematic comparison of interview-based losses versus objectively measured losses can be found in "Field Test Report on the Estimation of Crop Yields and Post-Harvest Losses in Ghana", <http://gsars.org/en/field-test-report-on-the-estimation-of-crop-yields-and-post-harvest-losses-in-ghana/>. The field test highlighted systematic under-reporting by the farmers.

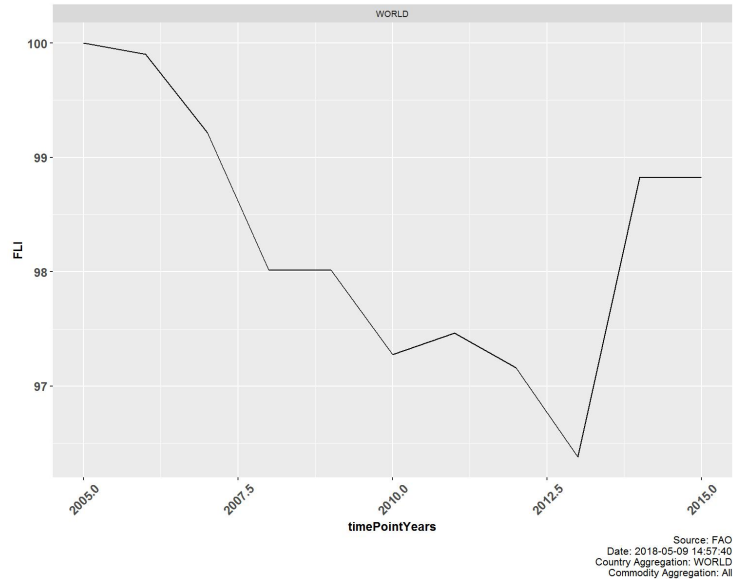


Figure 7. Global Food Loss Index (2005 = 100), in the period 2005-2015, using country-specific baskets of commodities (see list in Annex 2).

The estimated GFLI shows a downward trend until 2013 with an increase in the last two years. Part of the explanation is that the underlying officially reported data are systematically lower than loss factors found in technical assistance projects, scientific literature and the rapid assessments, and that the latter are increasingly available for recent years hence impacting on the overall results.

The above charts, however, should be read with caution. The models rests on very few observation points, hence many loss factors are estimated at commodity group level and are the same for many countries. They reflect the available data and the model's output rather than an accurate state of the world on Food Losses and Waste. As countries improve data collection efforts, it is likely that the loss percentages for countries will shift upwards.

## 5. Monitoring and Reporting

The SDG indicators' framework aims at providing stakeholders with a tool to monitor progress towards the Sustainable Development Goals. The Food Loss Index and Food Loss Percentage will help countries see their overall progress towards the target 12.3 to "reduce food losses along production and supply chains, including post-harvest losses."

As the custodian agency for the reporting and monitoring of the Global Food Loss Index (GFLI) and the countries' Food Loss Indices/Percentages (FLI/FLP), FAO will be able to collect and disseminate national food loss data from the countries, and support countries in measuring food losses. However, this will depend on what loss reduction efforts will be undertaken.

At the national level, reporting should be organized by the SDG coordination body and the focal point therein. It is planned that data collection initially take place through FAO's annual

Agricultural Production Questionnaire, adding no burden on the countries. A revised questionnaire section (still being tested) will include collection of the data and other relevant metadata.

Global monitoring will be organized in line with the overall SDG process.

## 6. Developed approaches to overcome obstacles and critiques in measuring Food Losses

Although the research on loss measurement has been ongoing for forty-years, the following known obstacles and critiques remained valid during the methodological development process:

- **No internationally endorsed standard, concepts, and definitions for food loss exist.** Several imprecise concepts and definitions that differ in some key aspects, are currently used and promoted by different key organizations. As a result non-comparable data across countries is generated, hindering any effective analysis. Food loss and waste are often used interchangeably.

*FAO has worked to minimize this challenge through the consultation on the definitions of losses and waste, through a long internal process and through external consultation. Definitional agreement will come from the consolidation of perspectives into a singular definition of losses. This acknowledges the difference in the conceptual completeness and operational ability to meet the objective, given the known issues with the availability of data and challenges of measurement in the field.*

- **Nationally generated and reliable food loss statistics are extremely scarce.** The proportion of official food loss data in the FAO FBS, over the last 25 years, amounts to a mere 4% of observations. The remaining data cells (about 200,000) are 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.

*FAO has worked to minimize this challenge through the creation and piloting of new cost-effective measurement guidelines and the improvement of the loss model to capture country specific policy variables and trends, the aggregation method of subnational estimates, as well as the improvements in estimation model at the global level.*

- **Available methods for measurement of food losses have not proved effective in generating data.**

*FAO has worked to minimize these challenge through 1) Cost-effective measurement techniques; 2) Preparing and testing measurement guidelines for a more diverse set of commodities; 3) improving the strategy for integrating information from the various methods of collecting data and how to build on the various methods; 4) Increasing the underlying knowledge base on post-harvest studies above what is being collected in the FAO Annual Agricultural Production Questionnaires; 5) Building a model and data collection tool that may uptake information from various sources.*

This lack of available data is due to the complexity of measurement along different stages of the supply chain including commodity characteristics, temporal dimension, and distributional aspects (e.g. pineapples follow a simpler chain than wheat, fresh meat would have shorter shelf life, etc.). The costs of collecting the data needed to capture the variability across regions and subsectors are significant, and capacity and resources may not be available.

In addition, information on the causes of losses have not always been collected, nor at the relevant geographic granularity to model their impacts on losses. These factors include, inter alia distributional impacts of losses (commercial vs. smallholders, differences in quality of the infrastructure; the levels of investment; farm practices, etc.).

The reliance on expert opinion, while useful in many respects to define the problems and identify hot spots, is challenging when carrying out repeated measures. The proposed approach addresses many of these challenges.

As the work has progressed, additional critiques and challenges have presented themselves.

- **Boundaries of losses along the food value chain.**
  1. To include harvest losses requires changing the definition of agricultural production, as it will change not the just the total amount of a commodity available but also the yield estimates.
  2. The inclusion of imports and exports implied using total supply as the reference quantity for calculating loss percentages by product. Imports and export markets can be separated from the domestic markets and add to complexities of the measurements.
  3. In many countries a wholesale market can become a retail market and food consumption location depending on time of day, further complicating how the SDG 12.3 indicator was defined.

*Harvest losses can be included in the Food Loss Index at the national level. The measurement of harvest losses has been included in the Guidelines. As for imports and export, the calculation of loss percentages has been adjusted in situations of import-dependency. The boundaries between wholesale and retail has been addressed in the*

*guidelines that recommend a set of questions for entities that combine wholesale and retail.*

- **The proposed index does not capture changing production patterns over time**

It is also known that a “Laspeyres-type” index, with fixed weights in the base period, tends to overestimate the true value of the index and that superlative index numbers reduce the bias.

*The SDG 12.3 formulation does not set a quantitative target for loss reduction but only the direction of the trend. The bias in the Laspeyres-type index will not alter the trend, it may bias the final level of the index. This choice for the weights has another advantage with respect to the data requirements: the international dollar prices are calculated with the Geary-Khamis equation system that use producer prices of all countries and commodities. A superlative index would require calculating the weights depending on the availability of the basic price data. One more advantage is that the fixed set of weights simplify the narrative of an indicator that is already perceived as very complicated.*

*As the proposed set of weights applies to the international index only and countries can use different weights at the national level; they may eventually use a different formula to compare results with the “Laspeyres-type” index and fine-tune its interpretation.*

*It is also recommended that the countries measure more than the ten commodities in the basket.*

- **Short-term shocks may not be captured in the time frames of the data collection.**

The methodology aims at estimating structural losses, yet short-term shocks can be frequent and relevant. Example are losses resulting from a new trade agreement, a failure in market prices, major power black-out for cold storage, or bumper crops (that could be considered as lurking over-production) that cannot be absorbed into the marketplace.

*The modelling efforts may help in addressing some aspects of this, but much of this challenge will be in the resources that are available at the country level to measure losses and model these shocks in a shorter time horizon.*

- **Qualitative losses where the products are not removed from the supply chain**

Qualitative losses can affect high volumes of products that become unfit for human consumption (e.g. infected with aflatoxin) but cannot be easily measured or identified, and remain in the food system destined for human consumption.

*Given the complexity and difficulty of loss measurement, the present proposal cannot address the quality dimension of losses and narrows the SDG objective to measuring quantitative losses. Where the issue is relevant for food safety and public health, countries can undertake additional measurement and data collection.*

## 7. Conclusion

The most controversial aspect of the indicator was the definition of food losses. FAO, in collaboration with countries, national and international experts and the UNEP has developed a conceptual framework on Food Losses and Waste that is being used for the GFLI. The methodology for computing the GFLI is rather straightforward. The tools needed for countries to measure, monitor and report on SDG 12.3 have been developed.

For this reason, it is proposed that the indicator be upgraded to Tier II.

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## 9. Glossary

| <b>Word/Term</b>   | <b>Definition</b>  |
|--|--|
| <b>Base Period</b>   | The period that losses are measured against. This is set by the SDG committee as the year 2015   |
| <b>Baskets of Goods</b>  | A set of 10 commodities selected for monitoring food losses for SDG 12.3   |
| <b>Conceptual framework</b>  | Theoretically complete accounting of what can be considered losses and waste, irrespective of ability, resources needed or practicality of measurement   |
| <b>CPC Central Product Classification</b>                          | The CPC is a comprehensive classification of products into a system of categories that are both exhaustive and mutually exclusive. It is based on a set of internationally agreed concepts, definitions, principles and classification rules. The term “products” follows the SNA definition, i.e. all output of economic activities that can be the object of domestic or international transactions or that can be entered into stocks, including transportable goods, non-transportable goods, services and other products. The CPC is highly compatible with the HS and ISIC and its custodian is the UNSD. For more information, see, <a href="http://gsars.org/wp-content/uploads/2015/12/Guidelines-for-Int-Classifications-on-Agricultural-Statistics-web.pdf">http://gsars.org/wp-content/uploads/2015/12/Guidelines-for-Int-Classifications-on-Agricultural-Statistics-web.pdf</a> |
| <b>Crop-livestock-fish product loss or Post-harvest loss (PHL)</b> | All quantity losses (food and non-food) along the Food Supply Chain for all utilizations (food, feed, seed, other) up to but excluding the retail to consumption level.  |
| <b>Edible</b>  | Refers to that element of food that a population of specific cultural or economic group traditionally consume  |
| <b>Food loss (FL)</b>  | In the production to distribution segments of the Food Supply Chain is mainly caused by the functioning of the food production and supply system or its institutional and legal framework. 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 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. Losses include the commodity as a whole with its non-edible parts.  |
| <b>Food Loss Index / Food Loss Percentage (FLI/FLP)</b>               | The indicator for the SDG 12.3.1 to cover the half of the indicator "on reduction of losses along the food production and supply chains"  |
| <b>Food Loss Percentage</b>   | Interpreted as the percentage of production/commodity that does not reach the next stage of the Food Supply Chain   |
| <b>Food Losses and Waste (FLW)</b>                                    | The decrease in quantity or quality of food   |
| <b>Food Supply Chain (FSC)</b>  | The connected series of activities to produce, process, distribute and consume food.  |
| <b>Food.</b>  | 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. (Codex Alimentarius Commission, Procedural Manual, 2013) |
| <b>Global Food Loss Index/Global Food Loss Percentage (GFLI/GFLP)</b> | The aggregated Indicator of all countries Food Loss Percentages/Food Loss Indexes, used to monitor the global progress of the SDG 12.3.1 Target   |
| <b>Harvest</b>  | Refers to the act of separating the food material from the site of immediate growth or production   |
| <b>Harvest losses</b>   | Occur during the harvesting process and may be due to, for example to shattering and shedding of the grain from the ears to the ground  |
| <b>Inedible Parts</b>   | Plants and animals produced for food contain 'non-food parts' which are not included in FLW.  |
| <b>Intended for human consumption</b>                                 | see the Codex Alimentarius definition of 'Food'   |
| <b>Operational Framework</b>  | Practical approach that focuses on definitions to produce consistent measurement  |
| <b>Pre-harvest</b>  | Constitutes the time frame between maturity and harvesting  |

|   |  |
|---|--|
|   | for crops  |
| <b>Qualitative FLW</b>  | Still eaten by people but has incurred reduction of nutritional value, economic value and/or food safety. The decrease of quality attributes of food without decrease in mass.   |
| <b>Quantitative FLW</b>   | The decrease in mass of food   |
| <b>Supply Utilization Accounts in the Food Balance Sheets (SUA/FBS)</b> | Food balance sheets provide essential information on a country's food system through three components: 1) Domestic food supply of the food commodities in terms of production, imports, and stock changes. 2) Domestic food utilization which includes feed, seed, processing, waste, export, and other uses. 3) Per capita values for the supply of all food commodities (in kilograms per person per year) and the calories, protein, and fat content. More information can be found at: <a href="http://www.fao.org/economic/ess/fbs/en/">http://www.fao.org/economic/ess/fbs/en/</a> |
| <b>Technical Conversion Factors (TCF)</b>                               | Used to convert product data from primary equivalent to secondary equivalent and/or vice versa. For example, live animal to meat or wheat into flour   |
| <b>The Guidelines</b>   | The publication document on the "Guidelines on the measurement of harvest and post-harvest losses" including the annexes covering on- and off-farm measurement in grains and pulses, fruits and vegetables, milk and livestock products, and fish products   |
| <b>Waste</b>  | Occurs from retail to the final consumption/demand stages  |

## 10. Resources

The following resources of specific interest to this indicator are available:

- FAOSTAT, food and agriculture related data:
  - <http://www.fao.org/faostat/en/#data>
- Global Strategy for Agriculture and Rural Statistics (GSARS):
  - <http://gsars.org/en/>
- Food Loss Analysis E-learning course
  - <http://www.fao.org/food-loss-reduction/news/detail/en/c/1111076/>
- Guidelines on the measurement of harvest and post-harvest losses
  - <http://gsars.org/wp-content/uploads/2018/04/GS-PHL-GUIDELINES-completo-03-002.pdf>

- [Training Course on Post-Harvest Losses](#)
  - In English <http://gsars.org/en/training-course-on-post-harvest-losses-english/>
  - In French <http://gsars.org/en/training-course-on-post-harvest-losses-french/#more-3949>

#### Additional links

- FAO – SDG portal
  - <http://www.fao.org/sustainable-development-goals/indicators/1231/en/>
- Community of practice (CoP)
  - <http://www.fao.org/food-loss-reduction/en/>
  - <http://www.fao.org/platform-food-loss-waste/food-loss/definition/en/>
- Malabo Declaration
  - <http://www.fao.org/food-loss-reduction/news/detail/en/c/250883/>
- Champions 12.3 - a group of leaders dedicated to inspiring ambition among peers, mobilizing action, and accelerating progress toward achieving SDG Target 12.3
  - <https://champions123.org/>
- FUSIONS (EU) on food waste
  - <https://www.eu-fusions.org/>
- WRI – food loss and waste standards
  - <http://www.wri.org/our-work/project/food-loss-waste-protocol>

## Annex 1: Losses defined by stage and commodity group

|                            | <b>Grains</b>  | <b>Fruits &amp; Vegetables</b>  | <b>Milk &amp; Meat</b> | <b>Fish</b>  |
|----------------------------|--|---|------------------------|--|
| <b>Pre-harvest loss</b>    | Losses that occur before the beginning of the harvesting process and that may be due to attacks by insects, mites, rodents, birds, weeds, or diseases afflicting and damaging crops. | Damage due to disease, insect, pest and biological or climatic reasons in any of the crop and commodity which is not fit for human consumption at the time of harvest is considered as pre-harvest loss.  |                        | The post-harvest refers to the period of time when a fish is separated from its growth medium. This includes the time a fish enters a net, is caught on a hook or in a trap.   |
| <b>Harvest loss</b>        | These occur during the harvesting process and may be due to shattering, mechanical damage and shedding of the grain from the ears to the ground.                                     | Quantity of produce lost during harvesting operations.  |                        | Harvest loss occurs mainly due to discard in good condition juveniles and low value fish. Harvest loss is the loss at the time of catch occurring at ponds/landing centres/boats/fishing crafts/trawlers etc.  |
| <b>Post-harvest losses</b> | Any losses occurring after the separation of the product from the site of immediate growth (harvest) to the moment it reaches the consumer   | Postharvest loss can be defined as reduction in available quantity of produce which becomes unfit for human consumption i.e. the degradation in quantity of a food production from harvest to consumption |                        | Post harvest losses occur immediately after the catch from ponds/landing centres/boats/fishing crafts/trawlers etc. to various marketing channels till reaches to the consumer level due to improper handling, insufficient icing, insufficient containers used for transportation of fish, delay in transportation, physical damage and chemical changes leading spoilage making it unavailable and unacceptable for human consumption. |

|  |  |  |  |   |
|--|--|--|--|---|
| <p><b>Transportation loss</b></p>                  | <p>For transportation, stock movement and other losses caused by spilling, losses are normally estimated as the difference in weight between the quantity loaded and the quantity unloaded. For long transport operations, grain samples can be taken at the loading stage and at the unloading stage, and then examined for changes in moisture content and qualitative damage during transit</p> | <p>Pilferage, spillage and damage during transportation of produce from one place to another are to be considered as transportation loss.</p>                                  | <p>Pilferage and spillage during transportation from one place to another are considered as transportation loss.</p> | <p>Pilferage, spoilage or damage during transportation from one place to another are to be considered as transportation loss.</p> |
| <p><b>Storage loss</b></p>                         | <p>For losses arising during storage – due to insects and molds – at farm level, the weight loss must always be related to the quantity in store at the time of the assessment</p>   | <p>The amount of produce which becomes unfit for human consumption due to rotting, infestation of insect and pest etc. during storage is to be considered as storage loss.</p> | <p>Quantity spoiled during storage.</p>  | <p>Rotten or damaged due to any of the reasons during storage is to be considered as storage loss.</p>                            |
| <p><b>Packaging, handling and distribution</b></p> | <p>Improper packaging of produce may facilitate pest infestation or the appearance of moulds and fungi leading to grain damage, weight loss, or rejection because of spoilage, especially if the produce is stored or transported for long periods. Improper handling may lead to grain damage and spillage, resulting in weight as well as quality losses. These</p>                              |  |  |   |

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|--------------------------|---|--|--|--|
|                          | <p>losses may arise at different phases, for example during transport from farm to storage and from storage to market, at different points of marketing channels, and at the wholesale and retail levels.</p>   |  |  |  |
| <p><b>Processing</b></p> | <p>Food grains are subjected to different types of processing before reaching the market and being finally consumed. For instance, paddy rice is generally de-husked or dehulled to obtain brown rice, manually by hand pounding or, more commonly, by machines such as rice hullers. When processing paddy, additional operations such as pre-cleaning, de-stoning, parboiling (pre-milling treatment), polishing and glazing may also be required. During these operations, losses are essentially due to damage to the grain, certain grain kernels resulting broken, and to spillage. A key efficiency parameter for rice milling is the recovery in terms of whole grain and the percentage of</p> |  |  |  |

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|  | <p>broken grains resulting from the milling process. For example, according to the International Rice Research Institute (IRRI), a good rice mill will produce 50 to 60 percent of head rice (whole kernels), 5 to 10 percent of large broken kernels and 10 to 15 percent of small broken kernels. Losses can be defined in relation to these efficiency standards</p> |  |  |  |
|--|---|--|--|--|



## Annex 2: FLI Commodity Baskets and corresponding CPC codes

|          | GFLI Basket         | FBS Group | Crop (CPC Heading)   |
|----------|---------------------|-----------|--|
| <b>1</b> | Cereals & Pulses    | Cereals   | Wheat (111), Maize (Corn) (112), Rice (113), Sorghum (114), Barley (115), Rye (116), Millet (118), Oats (117), Triticale (1191), Buckwheat (1192), Fonio (1193), Quinoa (1194), Canary Seed (1195), Mixed Grain (1199.02), Other Cereals N.E.C. (1199.9), Bulgur (23140.02), Rice, Milled (Husked) (23161.01), Rice, Milled (23161.02), Rice, Broken (23161.03), Communion Wafers, Empty Cachets Of A Kind Suitable For Pharmaceutical Use, Sealing Wafers, Rice Paper And Similar Products. (23490.01), Uncooked Pasta, Not Stuffed Or Otherwise Prepared (23710)   |
|          |                     | Pulses    | Beans, Dry (1701), Broad Beans And Horse Beans, Dry (1702), Chick Peas, Dry (1703), Lentils, Dry (1704), Peas, Dry (1705), Cow Peas, Dry (1706), Pigeon Peas, Dry (1707), Bambara Beans, Dry (1708), Vetches (1709.01), Lupins (1709.02), Other Pulses N.E.C. (1709.9)   |
| <b>2</b> | Fruits & Vegetables | Fruits    | Avocados (1311), Bananas (1312), Plantains And Others (1313), Dates (1314), Figs (1315), Mangoes, Guavas, Mangosteens (1316), Papayas (1317), Pineapples (1318), Other Tropical Fruits, N.E.C. (1319), Pomelos And Grapefruits (1321), Lemons And Limes (1322), Oranges (1323), Tangerines, Mandarins, Clementines (1324), Other Citrus Fruit, N.E.C. (1329), Grapes (1330), Apples (1341), Pears (1342.01), Quinces (1342.02), Apricots (1343), Sour Cherries (1344.01), Cherries (1344.02), Peaches And Nectarines (1345), Plums And Sloes (1346), Other Pome Fruits (1349.1), Other Stone Fruits (1349.2), Currants (1351.01), Gooseberries (1351.02), Kiwi Fruit (1352), Raspberries (1353.01), Strawberries (1354), Blueberries (1355.01), Cranberries (1355.02), Other Berries And Fruits Of The Genus Vaccinium (1355.9), Persimmons (1359.01), Cashewapple (1359.02), Other Fruits N.E.C. (1359.9), Raisins (21411), Plums, Dried (21412), Apricots, Dried (21419.01), Figs, Dried (21419.02), Other Fruit N.E.C., Dried (21419.99), Other Tropical Fruit, Dried (21419.91), Pineapples, Otherwise Prepared Or Preserved (21491), Flour Of Fruits (23170.04), Fruit, Nuts, Peel, Sugar Preserved (23670.02), Homogenized Cooked Fruit, Prepared (23991.03), Must Of Grape (24212.01), Fruit Prepared N.E.C. (F0623 ) |

|   |                                   |                          |   |
|---|-----------------------------------|--------------------------|---|
|   |                                   | Vegetables               | Asparagus (1211), Cabbages (1212), Cauliflowers And Broccoli (1213), Lettuce And Chicory (1214), Spinach (1215), Artichokes (1216), Cassava Leaves (1219.01), Watermelons (1221), Cantaloupes And Other Melons (1229), Chillies And Peppers, Green (Capsicum Spp. And Pimenta Spp.) (1231), Cucumbers And Gherkins (1232), Eggplants (Aubergines) (1233), Tomatoes (1234), Pumpkins, Squash And Gourds (1235), Okra (1239.01), Other Beans, Green (1241.9), String Beans (1241.01), Peas, Green (1242), Broad Beans And Horse Beans, Green (1243), Carrots And Turnips (1251), Green Garlic (1252), Onions And Shallots, Green (1253.01), Leeks And Other Alliaceous Vegetables (1254), Onions And Shallots, Dry (Excluding Dehydrated) (1253.02), Mushrooms And Truffles (1270), Green Corn (Maize) (1290.01), Other Vegetables, Fresh N.E.C. (1290.9), Locust Beans (Carobs) (1356), Chicory Roots (1691) |
| 3 | Roots, Tubers & Oil-Bearing Crops | Oil Crops                | Soya Beans (141), Groundnuts, Excluding Shelled (142), Cottonseed (143), Linseed (1441), Mustard Seed (1442), Rapeseed Or Colza Seed (1443), Sesame Seed (1444), Sunflower Seed (1445), Safflower Seed (1446), Castor Oil Seeds (1447), Poppy Seed (1448), Melonseed (1449.01), Hempseed (1449.02), Olives (1450), Other Oil Seeds, N.E.C. (1449.9), Coconuts, In Shell (1460), Oil Palm Fruit (1491.01), Palm Kernels (1491.02), Copra (1492), Karite Nuts (Sheanuts) (1499.01), Tung Nuts (1499.02), Jojoba Seeds (1499.03), Tallowtree Seeds (1499.04), Kapok Fruit (1499.05), Kapokseed In Shell (1499.06), Kapokseed, Shelled (1499.07), Groundnuts, Shelled (21421), Coconuts, Desiccated (21429.07), Prepared Groundnuts (21495.01)  |
|   |                                   | Roots, Tubers & Products | Potatoes (1510), Cassava, Fresh (1520.01), Cassava, Dried (1520.02), Sweet Potatoes (1530), Yams (1540), Taro (1550), Yautia (1591)   |
| 4 | Animals And Animal Products       | Animal fats              | Fat Of Pigs (21511.01), Pig, Butcher Fat (21511.02), Fat Of Poultry (21511.03), Cattle Fat, Unrendered (21512), Cattle, Butcher Fat (21512.01), Buffalo Fat, Unrendered (21513), Sheep Fat, Unrendered (21514), Fat Of Camels (21519.02), Pig Fat, Rendered (21521), Fat Of Other Camelids (21519.03), Poultry Fat, Rendered (21522), Tallow (21523), Lard Stearine And Lard Oil (21529.02), (21529.03), Degras (21932.01), Wool Grease And Lanolin (F0994 ), Fat Preparations N.E.C. (F1243 )  |
|   |                                   | Eggs                     | Hen Eggs In Shell, Fresh (231), Eggs From Other Birds In Shell, Fresh, N.E.C. (232), Egg Albumin (23993.01), Eggs, Liquid (23993.02), Eggs, Dried (23993.03)  |
|   |                                   | Meat                     | Snails, Fresh, Chilled, Frozen, Dried, Salted Or In Brine, Except Sea Snails (2920), Meat Of Cattle With The Bone, Fresh Or Chilled (21111.01), Meat Of Cattle Boneless, Fresh Or Chilled (21111.02), Meat Of Buffalo, Fresh Or Chilled (21112), Meat Of Pig With The Bone,   |

|   |                      |                           |   |
|---|----------------------|---------------------------|---|
|   |                      |                           | Fresh Or Chilled (21113.01), Meat Of Pig Boneless, Fresh Or Chilled (21113.02), Meat Of Sheep, Fresh Or Chilled (21115), Meat Of Rabbits And Hares, Fresh Or Chilled (21114), Meat Of Goat, Fresh Or Chilled (21116), Meat Of Camels, Fresh Or Chilled (21117.01), Meat Of Other Domestic Camelids, Fresh Or Chilled (21117.02), Horse Meat, Fresh Or Chilled (21118.01), Meat Of Asses, Fresh Or Chilled (21118.02), Meat Of Mules, Fresh Or Chilled (21118.03), Meat Of Other Domestic Rodents, Fresh Or Chilled (21119.01), Meat Of Chickens, Fresh Or Chilled (21121), Meat Of Ducks, Fresh Or Chilled (21122), Meat Of Geese, Fresh Or Chilled (21123), Meat Of Turkeys, Fresh Or Chilled (21124), Edible Offal Of Cattle, Fresh, Chilled Or Frozen (21151), Edible Offal Of Buffalo, Fresh, Chilled Or Frozen (21152), Edible Offal Of Pigs, Fresh, Chilled Or Frozen (21153), Edible Offal Of Sheep, Fresh, Chilled Or Frozen (21155), Edible Offal Of Goat, Fresh, Chilled Or Frozen (21156), Edible Offals Of Horses And Other Equines, Fresh, Chilled Or Frozen (21159.01), Edible Offals Of Camels And Other Camelids, Fresh, Chilled Or Frozen (21159.02), Edible Offals And Liver Of Chickens And Guinea Fowl, Fresh, Chilled Or Frozen (21160.01), Edible Offals And Liver Of Geese, Fresh, Chilled Or Frozen (21160.02), Edible Offals And Liver Of Ducks, Fresh, Chilled Or Frozen (21160.03), Edible Offals And Liver Of Turkey, Fresh, Chilled Or Frozen (21160.04), Meat Of Pigeons And Other Birds N.E.C., Fresh, Chilled Or Frozen (21170.01), Game Meat, Fresh, Chilled Or Frozen (21170.02), Other Meat N.E.C. (Excluding Mammals), Fresh, Chilled Or Frozen (21170.92), Offals N.E.C. (Excluding Mammals), Fresh, Chilled Or Frozen (21170.93), Pig Meat, Cuts, Salted, Dried Or Smoked (Bacon And Ham) (21181), Other Meat And Edible Meat Offal, Salted, In Brine, Dried Or Smoked; Edible Flours And Meals Of Meat Or Meat Offal (21183) |
|   |                      | Milk and Dairy            | Raw Milk Of Cattle (2211), Raw Milk Of Buffalo (2212), Raw Milk Of Sheep (2291), Raw Milk Of Goats (2292), Raw Milk Of Camel (2293), Skim Milk Of Cows (22110.02), Skim Milk Of Buffalo (22110.04), Skim Sheep Milk (22110.05), Skim Milk Of Goat (22110.06), Dairy Products N.E.C. (22290), Cream, Fresh (22120), Butter Of Cow Milk (22241.01), Ghee From Cow Milk (22241.02), Butter Of Buffalo Milk (22242.01), Ghee, From Buffalo Milk (22242.02), Butter And Ghee Of Sheep Milk (22249.01), Butter Of Goat Milk (22249.02),   |
| 5 | Fish & Fish Products | Fish & Fisheries Products | Cephalopods (2766), Crustaceans (2765), Demersal Fish (2762), Freshwater Fish (2761), Marine Fish, Other (2764), Molluscs, Other (2767), Pelagic Fish (2763), Fish, Seafood (2960), Aquatic Animals, Others (2769), Aquatic Plants (2775), Meat, Aquatic Mammals (2768), Aquatic Products, Other (2961)   |

|   |       |                 |   |
|---|-------|-----------------|---|
| 6 | Other | Spices          | Pepper (Piper Spp.), Raw (1651), Chillies And Peppers, Dry (Capsicum Spp. And Pimenta Spp.), Raw (1652), Nutmeg, Mace, Cardamoms, Raw (1653), Anise, Badian, Coriander, Cumin, Caraway, Fennel And Juniper Berries, Raw (1654), Cinnamon And Cinnamon-Tree Flowers, Raw (1655), Cloves (Whole Stems), Raw (1656), Ginger, Raw (1657), Vanilla, Raw (1658), Other Stimulant, Spice And Aromatic Crops, N.E.C. (1699)   |
|   |       | Stimulants      | Coffee, Green (1610), Tea Leaves (1620), Maté Leaves (1630), Cocoa Beans (1640), Cocoa Paste Not Defatted (23610.01), Coffee, Decaffeinated Or Roasted (23911), Chocolate Products Nes (F0666 )   |
|   |       | Sugars & Syrups | Sugar Beet (1801), Sugar Cane (1802), Other Sugar Crops N.E.C. (1809), Natural Honey (2910)   |
|   |       | Tree Nuts       | Almonds, In Shell (1371), Cashew Nuts, In Shell (1372), Chestnuts, In Shell (1373), Hazelnuts, In Shell (1374), Pistachios, In Shell (1375), Walnuts, In Shell (1376), Brazil Nuts, In Shell (1377), Areca Nuts (1379.01), Kola Nuts (1379.02), Other Nuts (Excluding Wild Edible Nuts And Groundnuts), In Shell, N.E.C. (1379.9), Almonds, Shelled (21422), Hazelnuts, Shelled (21423), Cashew Nuts, Shelled (21424), Brazil Nuts, Shelled (21429.01), Walnuts, Shelled (21429.02), Prepared Nuts (F0235 ) |

## Annex 2: List of the commodities appearing in the basket of at least one country's FLI

|   | GFLI Basket                       | FBS Group                | Commodity (CPC)  |
|---|-----------------------------------|--------------------------|--|
| 1 | Cereals & Pulses                  | Cereals                  | Wheat (0111), Rice, Paddy (0113), Maize (Corn) (0112), Barley (0115), Sorghum (0114), Millet (0118), Cereals, Nes (01199.90), Vetches (01709.01), Fonio (01193)  |
|   |                                   | Pulses                   | Beans, Dry (01701), Pigeon Peas (01707), Chick Peas (01703), Pulses, Nes (01709.90), Broad Beans, Horse Beans, Dry (01702), Lentils (01704), Lupins (01709.02), Cow Peas, Dry (01706), Grain, Mixed (01199.02)   |
| 2 | Fruits & Vegetables               | Fruits                   | Grapes (01330), Tomatoes (01234), Dates (01314), Bananas (01312), Pineapples (01318), Fruit, Citrus Nes (01329), Mangoes, Mangosteens, Guavas (01316), Fruit, Tropical Fresh Nes (01319), Apples (01341), Lemons And Limes (01322), Grapefruit (Inc. Pomelos) (01321), Fruit, Fresh Nes (01359.90), Oranges (01323), Leeks, Plantains (01313), Plums And Sloes (01346), Blueberries (01355.01), Papayas (01317), Strawberries (01354), Peaches And Nectarines (01345), Kiwi Fruit (01352)                |
|   |                                   | Vegetables               | Vegetables, Fresh Nes (01290.90), Other Alliaceous Vegetables (01254), , Green (01290.01), Carrots And Turnips (01251), Mushrooms And Truffles (01270), Avocados (01311), Garlic (01252), Chillies And Peppers, Green (01231), Lettuce And Chicory (01214), Spinach (01215), Onions, Dry (01253.02), Cabbages And Other Brassicas (01212), Cucumbers And Gherkins (01232), Onions, Shallots, Green (01253.01), Asparagus (01211), Pumpkins, Squash And Gourds (01235), Cauliflowers And Broccoli (01213) |
| 3 | Roots, Tubers & Oil-Bearing Crops | Oil Crops                | Sesame Seed (01444), Olives (01450), Coconuts (01460), Sunflower Seed (01445), Soybeans (0141), Rapeseed (01443), Linseed (01441), Groundnuts, With Shell (0142), Oil, Palm Fruit (01491.01), Mustard Seed (01442), Safflower Seed (01446)   |
|   |                                   | Roots, Tubers & Products | Potatoes (01510), Yautia (Cocoyam) (01591), Taro (Cocoyam) (01550), Cassava (01520.01), Sweet Potatoes (01530), Yams (01540), Roots And Tubers, Nes (01599.10)   |
| 4 | Animals Products                  | Meat                     | Meat, Cattle (21111.01), Meat, Sheep (21115), Meat, Chicken (21121), Meat, Pig (21113.01), Meat, Goat (21116)  |
| 6 | Other                             | Spices                   | Chillies And Peppers, Dry (01652), Pepper (Piper Spp.) (01651)   |
|   |                                   | Stimulants               | Cocoa, Beans (01640), Coffee, Green (01610)  |
|   |                                   | Sugars & Syrups          | Honey, Natural (02910), Sugar Beet (01801), , Sugar Cane (01802)   |
|   |                                   | Tree Nuts                | Almonds, With Shell (01371), Pistachios (01375), Nuts, Nes (01379.90), Hazelnuts, With Shell (01374), Walnuts, With Shell (01376), Brazil Nuts, With Shell (01377), Chestnut (01373)   |

