SDG Indicators under FAO Custodianship

SDG 12.3.1 – Global Food Loss Index

December 2018
OBJECTIVES

Understand the SDG target 12.3 and indicator 12.3.1

Understand the difference between measuring and reporting on food losses at country-level and at disaggregated level

Clarity on definitions, concepts and boundaries

How to set priorities and address the challenges

How to calculate the country Food Loss Index (FLI) and Global Food Loss Index (GFLI)
  - How it is interpreted
  - What goes into the index
GOAL 12: RESPONSIBLE CONSUMPTION AND PRODUCTION

Target 12.3: “By 2030 halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses”

The target has been split into 2 sub-indicators, under FAO and UN Environment custodianship respectively.

“By 2030, …

12.3.1.a Food Loss
“…reduce food losses along production and supply chains, including post-harvest losses.”

12.3.1.b Food Waste
“…halve per capita global food waste at the retail and consumer levels.”
Target 12.3: “By 2030 halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses.”

Food Loss Index
Focuses on the supply side of the market and decreasing losses in the supply chain

“By 2030, …

Food Waste Index
Focuses on retail and consumer sectors and improving the efficiency on the demand side of the supply chain

“…halve per capita global food waste at the retail and consumer levels.”

“…reduce food losses along production and supply chains, including post-harvest losses.”
BOUNDARIES BETWEEN THE SUB-INDICATORS: THE FOOD SUPPLY CHAIN IN THE FLI

Food Loss Index
SDG 12.3.1.a

Losses in the FBS

Food Waste Index
SDG 12.3.1.b

Stages of the Food Systems

Pre-harvest/Pre-slaughter
Harvest/Slaughter
On-farm Post-harvest/Slaughter Operations
Transport Storage Distribution
Processing & Packaging
Retail
Public & Household Consumption

Food Losses Index at the national level
SDG 12.3.1.a

Harvest losses
can be added to the index coverage and measured with crop-cutting surveys
CHALLENGES THAT SDG INDICATOR 12.3.1 HAS ADDRESSED

- A measurable definition of Food Losses has been internationally agreed.
- Guidelines on how to define and collect harvest and postharvest losses data of crops, animal, and fish products have been developed and tested.
- Complexity of measurement has been accounted for addressing the multiple dimensions (stages of the value chain, typologies of actors, product characteristics, value chain length and complexity) and minimizing data costs.
- Reporting both the national and international indicators in a comparable way is possible.

THE REMAINING CHALLENGE IS THAT

- Reliable nationally representative data on losses are generally not available (4.4% official data reported yearly in FAOSTAT).
- Mainly case studies based on expert opinions focused on few products or stages of the value chain.
MEASURED DEFINITION OF FOOD LOSSES

FAO definition of Food Losses used for Agricultural Statistics and the FLI

**Food losses** Crop and livestock product losses cover all *quantity losses* along the supply chain for all utilizations (food, feed, seed, industrial, other), up to but not including the retail/consumption level. Losses of the commodity as a whole (including edible and non-edible parts) and losses, direct or indirect, that occur during storage, transportation and processing, also of relevant imported quantities, are therefore all included.

**Translated into operational measurement means:**

- Quantities
- All supply stages (Harvest-Retail)
- Any amount that leaves the chain for any reason
  - “waste” occurring on the supply side is measured under “losses”
  - Information on the causal factors is collected irrespective of intentionality to allow for ex-post policy and analysis
- Non-food utilizations are NOT losses (e.g. feed, biofuel production, etc.)
- Includes Edible + Inedible parts
- Losses are tracked by commodity starting on the production site
FOOD LOSS INDEX (FLI) - MAIN PRINCIPLES AND METHODOLOGY

1. Focuses on 10 key commodities in 5 main groups
2. Monitors Food Loss Percentages (FLP) and not on total losses
3. Monitors changes in the Food Loss Percentage over time
4. Based on nationally representative loss data along the supply chain
Why percentage losses and not total losses?

- In many cases, a flat percentage based on expert opinion is used to estimate losses over a period of time.
- When applied to production quantities, total losses will fluctuate proportionally to production, but in reality nothing in the system has changed.

Country example. Total losses are estimated using a constant factor of 15%. Production and losses in tons fluctuate.
COMPILING THE FOOD LOSS INDEX (FLI)

A Food Loss Percentage can be interpreted as the percentage of production that does not reach the retail stage.

Steps to compiling the FLI, if the data exists:

1. Select Basket of commodities and compile weights
2. Compile Food Loss Percentages (FLP)
3. Compare FLP’s over time

Food Loss Index
Loss percentages in the FLI can be survey-based or model-based estimates.

Survey-based estimates are not trivial to obtain, but FAO has developed guidelines for data collection and strategies to support countries in getting the loss estimates by commodity.

\[ w_{ijt} \] is the loss percentage (estimated or observed)

where \( j = \text{commodity}, \ i = \text{country}, \ t = \text{year} \)
The Food Loss Percentage (FLP) of the whole basket of commodities at country level is calculated as:

\[ FLP_{it} = \frac{\sum_{j=1}^{n} l_{ij} \times (q_{0} \times p_{0})}{\sum_{j=1}^{n} (q_{0} \times p_{0})} \]

The FLP is a weighted average of the loss percentages of the selected 10 commodities in the basket.
Each commodity’s supply chain can be disaggregated down to stage. Estimates for the different stages can come from various sources and tools.

Food Loss Percentage↓\text{it} = \frac{\sum_{j\uparrow} l_{ij}t \times \text{weights}↓t=0}{\sum_{j\uparrow} \text{weights}↓t=0}

nationally representative loss percentages (l_{ij}) by commodity
Calculate the country Food Loss Index

$$FLI_{it} = \frac{FLP_{it}}{FLP_{i0}} \times 100$$

**Where:**
- $$i = \text{country}$$,
- $$t = \text{year}$$
- $$t_0$$ is the base year (set at 2015 for the SDG monitoring)
- $$FLP_{it}$$ is the country Food Loss Percentage

The country FLI shows the change in the Food Loss Percentage over time (compared to a base period)

*This is sub-indicator 12.3.1.a for SDG reporting and monitoring*
Food Loss Index \( (\text{country } i, \text{ year } t) \downarrow = \frac{\text{Food Loss Percentage}\downarrow i \text{ (year } t)}{\text{Food Loss Percentage}\downarrow i \text{ (Baseline year)}} \times 100 \)
Countries’ FLI must be aggregated for SDG monitoring by regions and for the world, which will be done as part of FAO’s custodial role.

\[
GFLI_{t} = \frac{\sum_{i=1}^{G} GFI_{i} \cdot w_{i}}{\sum_{i=1}^{G} w_{i}} \times 100
\]

Where:
- \( w_{i} \) are the country weights equal to the total agricultural value of production
UNDERLYING DECISIONS IN THE FOOD LOSS INDEX
Reducing losses falls into several policy objectives …

- Improving competitiveness and value-added of agricultural producers and value chain actors;
- Increasing the efficiency of supply chains through logistics, infrastructure, and equipment
- Addressing risks that come from changes in the climate and economic conditions.
- All while improving the welfare of the population, particularly those in extreme poverty or with severe food shortages.

… which policy applies affects the data needs
WHAT COMMODITIES IN THE BASKET?

Setting a common basket of goods for global monitoring is a challenge:

- the same commodities are not relevant for all countries
- loss statistics cannot cover the entire food production and diet

There is a trade-off between relevance at country level and comparability across countries.

**Comparability**

Ensure comparability by main product category across diverse diets:

1. Cereals & Pulses;
2. Fruits And Vegetables;
3. Roots, Tubers & Oil-Bearing Crops;
4. Animals products;
5. Fish products
6. Optional: Other crops (stimulants, spices, sugar, etc.)

**Relevance**

Countries determine the two commodities in each heading based on

- Policy focus
- Economic relevance
- Food security relevance
WHAT COMMODITIES IN THE BASKET?

The Basket must be nationally relevant and cover 5 dietary groups.

The default process is to:

- Compile value of production for every commodity (in the base year)
- Group commodities by category and rank them
- Select the top 2

National priorities may replace the default basket
SELECTING THE BASKET OF COMMODITIES, THINGS TO CONSIDER

Countries can go beyond the default basket of 10 commodities:

- Increase the number of commodities if needed
  - the policy focus can shift over time
  - the highest value products can change over time (e.g. in the Fruits and Vegetables category the top 2 items changed in 40% of countries).

- Capture variability inside each group if needed
  - Similar commodities (walnuts and pistachios; goats and sheep; etc) will likely be similar in perishability, but economic factors may trigger differences in losses
WHAT ARE THE CHOICES FOR THE WEIGHTS?

The weights give each commodity its relative importance.

Weights are fixed in the reference year: the index changes only if percentage losses change.

Several kinds of weights are possible.

The weights in SDG sub-indicator 12.3.1.a are equal to the value of production of the commodities in the basket.
WHAT ARE THE CHOICES FOR THE WEIGHTS?

Economic value – emphasis on losses that are market driven, bias towards higher valued commodities, commodity groupings adjust against bias; useful for ascertaining benefits-costs of policy

Other Weights can be applied in parallel to show impact of a change in losses on other policy areas

- Contribution to diets (caloric or protein value) - bias towards staples or meats, no emphasis on fruits and vegetables which might need more resources to grow & transport, higher energy consumption and which are more perishable

- Environmental factors (water or CO2) – Bias against meats and fruits and vegetables and nuts, as well as production systems by country
FOOD LOSS MEASURES

Current state of knowledge and next challenges
THE REAL CHALLENGE IS IN MEASURING THE LOSS PERCENTAGE $l_{ijt}$

Below a loss percentage lie the complexities of food losses and its multiple dimensions (stages of the value chain, typologies of actors, product characteristics, value chain length and complexity)
Measuring $l_{ijt}$ is at the core of the matter. There are several available tools:

- Preliminary assessments to identify the critical loss points
- Full-sample surveys to construct national loss estimates by product
- Experimental designs to estimate losses from common practices
- Qualitative approaches (e.g. focus groups) to better understand dynamics under post-harvest management practices
- Modelling to improve the quality of the estimates, expand on experimental design or measure the impact of policies and investments on food losses

A range of instruments is needed to address the measurement challenge.
FOOD LOSS DATA AVAILABILITY – MANAGING GAPS

Available information refers mostly to cereals and industrialised countries.
FOOD LOSS DATA AVAILABILITY – MANAGING GAPS

Regions and commodities are unevenly covered
FAO has built a database of all published and accessible sub-national data on food losses. The data is downloadable, searchable and sortable by stage of the value chain, year, country, commodity group, Method of data collection, original source, etc. Contact us to contribute to the dataset if you have more information.
DATA COLLECTION
STRATEGY & RECOMMENDATIONS

FAOs approach has focused on more **cost-effective** and simplified methods to strengthen the knowledge base through:

- **Improving data collection**
  - Starting with the rapid appraisal & case study methods **and** moving to more strategic but nationally representative estimates in **critical loss points**
  - Policy can drive further disaggregation at stages (e.g. export markets vs subsistence)
  - Assess current data collection efforts and how they can be improved for loss data collection (e.g. link data collection to instruments already used in-country)
  - Strategies and complexities by each stage are outlined in the Guidelines
  - Improve cost-effectiveness by collected and estimated with a variety of tools
- **Strengthen National estimates through national statistics that can be consistently collected**
- **Improving the predictive power of models (in years where data is not collected)**
Food loss is a complex issue, often with multiple and interrelated causes operating at different levels. This e-learning course introduces the FAO Case study methodology for the analysis of critical food loss points. This method focuses on revealing and analyzing the multidimensional causes of losses in selected food supply chains, identification of critical loss points, and recommendation of feasible food loss reduction solutions and strategies.

USE OF THE FOOD LOSS ANALYSIS (FLA) OUTPUTS

- Identification of **Critical Loss Points** of selected Food Supply Chains (FSC) to prioritise measurements and loss reduction investments and actions
- Identification of **major causes of losses (technical / economic / social)** at different levels micro–meso–macro levels for modelling and policy-making
- Identification/assessment of **solutions and strategies** for decision-making

Start with understanding the flow of the commodity through the country and where are the critical loss points, what data exists, and then move deeper with the data collection guidelines where measurement and more precise numbers are needed.
DATA COLLECTION METHODS: GUIDELINES ON THE MEASUREMENT OF LOSSES

Measuring $l_{ijt}$ is at the core of the matter.

- Range of surveys and sample-based statistical tools
- To obtain nationally representative loss estimates in a cost-effective manner
- Grounded in the National Statistics Systems
- Drawn from 40 years of methodological literature and field practice

**Grains**

Published and tested

Fruits and Vegetables, Milk and Meat, Fish and products
Questionnaires developed in the pilots will be available in the joint FAO/World Bank Survey Solutions CAPI software for countries to add to and adjust for local factors.

- Allows for logical validations
- Skips unnecessary sections
- Quicker results and GPS capabilities
- Covers inquiry based and actual measurement approaches
The guidelines walk through the recommendations by stage for collecting data and how to aggregate and expand to the national level.

### Farm
- **Recommendation:**
  - **Harvest losses - Crop-cutting surveys**
    - Different yield, different definition of production
  - **Post-harvest losses – Sample surveys**
    - Relevant when there are very many small actors
    - May cover on-farm storage, on farm transportation
    - Can be complemented by experimental design or two-stage sampling practices
  - **Post-harvest losses – complete enumeration**
    - Large commercial farms that keep accounting records (few)

### Storage
- **Recommendation:**
  - Losses and quantities stored
  - Model or experimental design
    - Inventory of storage facilities with their characteristics
    - Controlled experiment of the various products, length and storage conditions
  - Administrative data
    - Very large storage facilities
    - Accurate accounts and records
  - Farm sample survey (on-farm storage)
    - Smallholder farms (large population, small quantities)
  - Auxiliary data: Administrative data
    - Weather at harvest
    - Monthly Prices

### Transport
- **Recommendation:**
  - Losses and quantities: Sample survey of the trucks
  - Measuring a sample of product at destination

### Wholesale
- **Recommendation:**
  - Agreement with the private sector
    - Quantities sold through the market, discarded product
    - Sample or traders in the wholesale markets

### Processing
- **Recommendation:**
  - Agreement with the private sector
    - Companies accounting records
    - Complete enumeration or experimental design

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**Stage** | **Recommendation**
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Farm | • Harvest losses - Crop-cutting surveys  
• Different yield, different definition of production
• Post-harvest losses – Sample surveys  
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• May cover on-farm storage, on farm transportation  
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• Post-harvest losses – complete enumeration  
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Storage | • Losses and quantities stored
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Wholesale | • Agreement with the private sector
• Quantities sold through the market, discarded product
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Processing | • Agreement with the private sector
• Companies accounting records
• Complete enumeration or experimental design
Training course on postharvest losses surveys for grains

Training course on SDG 12.3.1 Global Food Loss Index: in progress
LOSS MODEL

Estimating losses at the national level when limited data is available or to complement existing measurement.
FAO developed a food loss imputation model for countries that do not have any loss data or to expand on limited available information at sub-national level.

The model uses data from the Food Balance Sheets in FAOSTAT and data from an extensive scientific literature review, published by FAO in a separate dataset.

The model can be adapted at the country level.

The model estimates over
- Clustered commodities
- Eight explanatory variables selected with an algorithm over a dataset of 200+
- Mixed effect model structure
CLUSTERED COMMODITY GROUPS

Assume that commodities will have similar causes and rates of losses within the commodity groups.

- E.g. Corn and lentils vs. Corn vs. fresh milk
- Don’t want the higher losses of one commodity impacting the modeling framework.
- Types of value chains and critical loss points, as well as solutions are similar within the groups
- But there may be factors that impact multiple supply chains – e.g. electricity, infrastructure

The model uses all available loss data world-wide. Any improvement in the data will contribute to improve the model-based estimates.
VARIABLE SELECTION

Literature provided theoretical basis for the explanatory variables

Proxies were needed to represent variables that could be collected only at the national levels on:

- Storage
- Transportation
- Input Costs (Fertilizer, etc.)
- Energy
- Investment/Monetary
- Social/Economic
- Weather/Crop

The variables were sourced from international organizations. For example:
- Quantities of Energy used in Agriculture from IEA by country
- Metal and Fertilizer prices from the World Bank Pink Sheets
- Capital Stock values from FAOSTAT
- Access to electricity (% of population)
- Etcetera

Variables can be adjusted at the country level for estimating the impact of relevant policies
VARIABLE SELECTION

- Variables were chosen based on their predictive performance in a RandomForest algorithm, as to allow for variability between different supply chains and countries.

- The algorithm helps narrow down the variables to the ones that matter for each of the commodity groups by country, improving the estimation for countries that have some data availability.
MODEL SPECIFICATION

\[ y_{ijt} = \alpha + x_{ijt}^\top \beta + z_{ij}^\top \gamma + u_{ijt} \]

where:

- \( y_{ijt} \) is the percentage of food losses for the country \( i \), for a given commodity, \( j \), at time \( t \)
- \( x_{ijt}^\top \) is the \( k \)-dimensional row vector of time and commodity varying explanatory variables
- \( z_{ij}^\top \) 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

- Fixed Effects Model
- Within the clusters, the fixed effects are on country and commodity
- Vector of 8 variables selected from the larger dataset – chosen by the commodity group
- Model performs better in clusters with more data
- When not enough data exists a simple average is applied
VISUALIZATION OF DATA USED IN THE MODELS

Data In
- Protected Loss % Data
- Loss % estimates from other sources

Clustering & Subsetting Data In (repeat for all clusters)
- Cereals - Loss % on production
- Country Cereal Crops
- Global cereal Crops
- Protected % data

Data Out
- Global % Estimates
  (same variables for each commodity group; differences between estimates in this group will be driven by the country & commodity dummy variables, and levels of the variables)
- Country % Estimates
  (different variables selected for each country & commodity group)
- Country % carry-overs
- Protected % data

Carry-over estimates where no variation exists; repeats over each commodity within cereals for the specific country

Global cereal Model, estimates for all countries
Country Cereal Model, estimates only the country selected; Repeat for each country with data
The following FAO products can be provided to all countries upon request:

- Methodological documentation for the SDG indicator 12.3.1 and the model
- Guidelines for data collection
- Training material and elearning
- An Excel calculation sheet to test the index compilation for each country and a narrative report of a pilot country
- The default basket selection
- Any available data that FAO has collected, including all loss data currently used in the model and the model-based estimates
FAO TECHNICAL SUPPORT TO COUNTRIES

- Knowledge transfer through regional workshops and e-learning course for regional and national partners on the guidelines and SDG 12.3

- Support to the data component of other FAO or international partners projects to improve the evidence-base of any policy

- Developing food loss surveys or improving food loss estimates using the Guidelines through capacity development projects

- Support pilot surveys to measure food losses in specific critical loss points or tracts of the supply chain (such as transport)

- Support in measuring the impact and cost-effectiveness of some loss reduction strategies (packaging, farming techniques, storage technology, etc..)
THANK YOU

CONTACT US!

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For more detailed information on indicator 12.3.1.a please see:
The following resources of specific interest to this indicator are available:

**FAOSTAT, food and agriculture related data:**

**Global Strategy for Agriculture and Rural Statistics (GSARS):**

**Food Loss Analysis E-learning course**

**Guidelines on the measurement of harvest and post-harvest losses.**

**Training Course on Post-Harvest Losses**
- In English
- In French

**Additional links**

**FAO – SDG portal**

**Community of practice (CoP)**

**Malabo Declaration**

**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/](https://champions123.org/)

**FUSIONS (EU) on food waste**
- [https://www.eu-fusions.org/](https://www.eu-fusions.org/)