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Methodological proposal for measuring the food loss sub-indicator SDG 12.3.1[1]

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1. Abstract

Measuring and monitoring the sub-indicator SDG 12.3.1.a Food Loss Index is complex and requires several data collection efforts to cover the various food groups and their stages along the food supply chain. Currently, in Mexico, there are no estimates for each of the food groups and their various supply chains that would allow for measuring this indicator. To overcome prevalent data gaps, the INEGI and FAO technical team has conducted a desk study to compile the SDG 12.3.1.a Food Loss Index, Mexico's compilation strategy integrates two types of data: national estimates and fixed factors. National estimates are drawn from the National Agricultural Survey (ENA) conducted biannually by INEGI, which currently captures on-farm (post-harvest) losses for selected crops. For off-farm supply chain stages and commodities lacking national measurements, fixed factors are used. These factors are derived from approximations from existing studies, pilot surveys, or synthetic estimations, and are intended to be progressively replaced by future national measurements. The pilot exercise focused on a basket of 11 food commodities selected based on food security criteria and ENA data availability. The methodology involved mapping supply chains, integrating available loss data into a database, constructing a loss percentage matrix, and finally aggregating the weighted losses. This first compilation yielded an approximate food loss percentage of 9.31 percent for the selected basket.

Keywords: Food Loss Index; SDG 12.3.1.a; food loss measurement; agricultural surveys; supply chain losses; data integration; methodological framework; Mexico.

[1] The present article is derived from work carried out in collaboration between FAO and INEGI on the Pilot exercise to compile Sustainable Development Goal Subindicator 12.3.1.a. The referenced document has already been officially published and is available at the following link: https://openknowledge.fao.org/items/1df53b2a-ae9d-43cb-9ee3-689143d6778f . The author declares that the text and materials presented in this manuscript are free from any copyright violations.

2. Introduction

Sustainable Development Goal (SDG) Target 12.3 calls for halving per capita global food waste at the retail and consumer levels and reducing food losses along production and supply chains by 2030. To monitor progress toward this target, the Food Loss Index (FLI) – SDG Sub-Indicator 12.3.1.a – was formally adopted by the United Nations in 2019 following the development of an internationally agreed methodology led by FAO. The indicator measures trends in food loss percentages from harvest up to, but excluding, retail, and is compiled as a fixed-weight index to ensure comparability over time and across countries.

Implementing this methodology at the national level presents technical and institutional challenges, particularly in generating reliable and consistent food loss data across multiple supply chain stages. While farm-level losses can often be integrated into agricultural surveys and censuses, measuring losses beyond the farm gate requires additional statistical instruments, interinstitutional coordination, and cost-efficient strategies. The methodology therefore encourages countries to prioritize key commodities and critical loss hotspots while leveraging existing national statistical systems.

In this context, Mexico has established a solid foundation for compiling SDG Sub-Indicator 12.3.1.a. Food loss modules have been incorporated into the National Agricultural Survey (ENA), and complementary initiatives—such as the Production, Marketing and Price Survey (EPCP)-provide additional information across supply chain stages. Through technical cooperation between INEGI and FAO, these data sources are being systematically integrated into a coherent methodological framework that allows for the compilation of the Food Loss Index using nationally representative information, fixed production-value weights, and standardized aggregation procedures.

This document presents the conceptual and methodological framework adopted for Mexico, outlining the integration of available data, the construction of loss matrices by commodity and supply chain stage, and the procedures for compiling and reporting the Food Loss Index in a transparent, consistent, and internationally comparable manner.

3. FAO methodology for SDG indicator 12.3.1

The Food Loss Index (FLI) is a fixed-weight index (Laspeyres-type) widely used in official statistics. The FLI is based on the Food Loss Percentage (FLP), which measures the percentage of food losses of a food basket in each country. The Index converts the FLP into an index with a base level of 100 in the base year and compares the FLP of subsequent years with that of the base year, to monitor increases or decreases in food losses relative to the base year (FAO, 2018a).

The estimator of the Food Loss Percentage, FLP_{it} ,for country $i$in year t, is composed of the loss percentages of each food item in the basket along the supply chain (from production up to, but excluding, the retail stage), represented by l_{ijt})country i, product j, year t). The loss percentage of each crop is weighted by its value of production* relative to the total production value of the basket in the base year, where $q_0$denotes the production of product $j$in the base year and $p_0$its corresponding price. For this purpose, a three-year average is used (if the base year is 2015, the average of 2014, 2015 and 2016 is applied).

$$FLI_{it} = \frac{FLP_{it}}{FLP_{it_0}} * 100$$

$$FLP_{it} = \frac{\sum_j \boldsymbol{l_{ijt}} * (q_0 * p_0)}{\sum_j (q_0 * p_0)} = \sum_j \boldsymbol{l_{ijt}} * \omega_{j0}$$

Key characteristics:

- Focuses on 10 products across 5 product groups.
- Measures the percentage of losses, rather than volume.
- Monitors change over time.
- It is based on nationally representative data on food losses.

4. Strategy for measuring food losses at the national level and aggregating information at the supply chain level for the product basket.

Based on the identified stages in the supply chain, the second and crucial goal of the mapping exercise is to estimate the volume traded in each of these stages. This helps assess the number of potential loss points and the importance of each stage and sector in terms of the volume handled. The volumes traded by each stage and sector can then be used as structural factors of the supply chain for aggregating losses along the chain.

Once loss data is available for the products and their corresponding stages of the supply chain, the main steps are as follows:

1. Establish the base year, (SDG 2015 or alternatively the first year of reporting.)
2. Aggregate the loss percentages along the supply chain,
3. Calculate the weights, based on the value of production of each product.
4. Compile the Basket Loss Percentage, by applying the corresponding weights.
5. Compile the Food Loss Index, by applying the base year.

5. Compilation exercise of SDG 12.3.1 in Mexico

For Mexico, the selection of the **food basket** is primarily based on products included in the National Agricultural Survey (ENA) (INEGI, 2024b), which constitutes the main available source of information on food losses. At present, the food groups of roots and tubers, animal products, and fishery and aquaculture products are not covered, mainly because data on food losses for these groups are not collected in the ENA. As the country defines a strategy for measuring food losses for these food groups, it is recommended that they be incorporated into the Food Loss Index for reporting on SDG Indicator 12.3.1(a).

Selected food basket by Mexico:

Food group	Product
Cereals and Pulses	Maize
	Wheat
	Beans
Fruits and Vegetables	Tomatoes
	Bananas
	Avocados
	Apples
	Oranges
	Lemons
	Pumpkins and courgettes
	Onions

5.1 Integration of available food loss data

The structure of Mexico's food loss database is built from the mapping of available surveys, studies, and statistical sources in order to compile information for calculating the SDG Food Loss Index. Because available data differ in coverage, methodology, and definitions, integrating them requires reviewing multiple dimensions to ensure comparability and validation. Information may cover the entire supply chain or only a specific stage; it may represent all actors or only certain subgroups (such as smallholders or large firms); and it may include all activities within a stage or focus only on specific operations like storage or transport. Data can also be reported by individual crop, crop variety, production system, or aggregated food group, leading to varying levels of precision.

Geographical scope is another important dimension, as official statistics are generally national, while many loss studies are conducted at the subnational level. Differences also exist in the definition of food loss (for example, whether edible parts or reuse for animal feed are included) and in measurement methods, which may result in over- or underestimation. To address these variations, the database incorporates a quality classification system that assigns greater weight to nationally representative surveys and physically measured data, and lower weight to indirect estimates or expert opinion. This approach allows for appropriate weighting of each data point when constructing the loss percentage matrix by crop and supply chain stage.

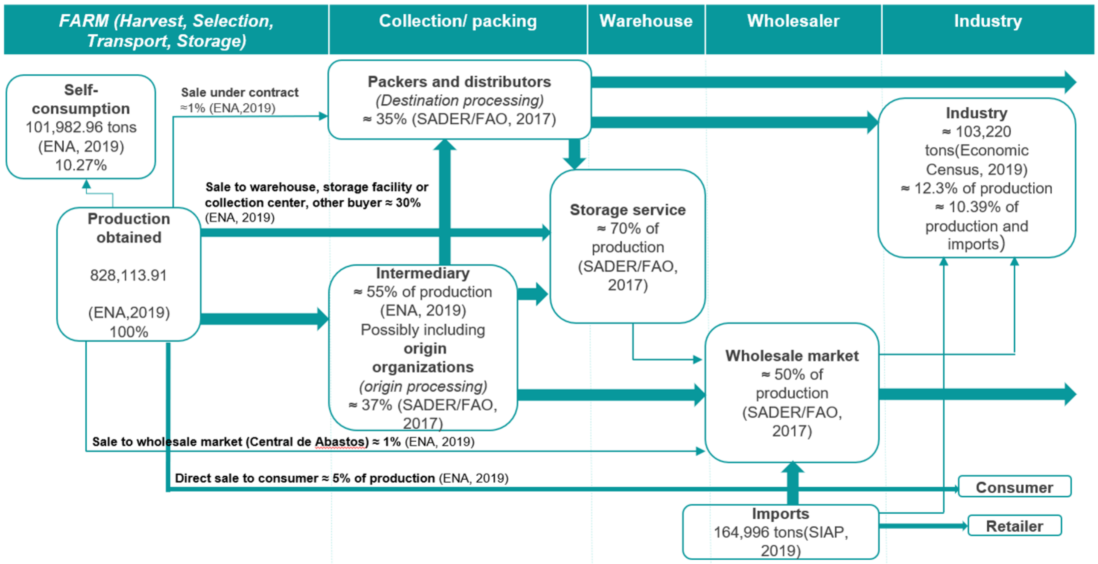
	Farm (ENA 2019)	Collection center	Warehouse	Wholesaler	Processing plants
	Loss %	Loss %	Loss %	Loss %	Loss %
White maize	3.3	5.9*	4.7*		2.5*
Beans	4.8	5.0*	1.8*	4.5*	3.6*
Wheat	0.4	2.4*	3.4*		1.8*
Avocados	2.4	**2.2***		**4.0***	
Pumpkins and courgettes	8.9	**7.2***		**9.2***	
Tomatoes	1.4	**7.3***		7.3*	
Onions	3.2	9.3*		5.0*	
Lemons	2.4	5.9*		**10.5***	
Apples	2.0	**9.5***		**6.3***	
Oranges	8.7	**7.5***		**9.7***	
Bananas	1.5	**2.7***		**6.3***	
	Information to be updated with each ENA survey round.				
	Synthetic estimation approach				
*	Fixed food loss percentage factors that will remain unchanged until national surveys or other monitoring instruments are implemented.				

5.1.1 Example of the mapping of the bean supply chain and approximations of the volumes handled at each stage (as a percentage of production).

The mapping was developed based on multiple information sources and statistical data analysis compiled through the research.

The mapping considered **production plus imports** for products in which imports represented more than **10 percent of domestic production**, in accordance with FAO methodology. For the selected food basket, this applied to beans (figure 1), wheat and apples.

Figure 1. Beans: mapping of the chain and the main volumes traded (in % of total production)



	Farm		Collection/ packing	Warehouse	Wholesaler	Industry
Percentage of production handled at the stage	100%		≈ 90% of production	≈ 70% of production	≈ 50% of production	≈ 10.39% of production and imports
Share of production exiting the supply chain at the stage	Self-consumption	10.27%				
	Direct sale to consumers	≈ 5%				

In addition, the mapping incorporates the **shares of production that exit the agri-food supply chain at each stage**. For example, self-consumption, on-farm use for animal feed, and direct sales to consumers represent shares of production that do not enter subsequent stages of the chain; therefore, the percentages at downstream stages are **lower than 100 percent**.

	Farm (ENA 2019)	Collection center	Warehouse	Wholesaler	Processing plants
White maize	**100%**	72.00%	29.00%	30.00%	12.00%
Beans	**100%**	90.00%	70.00%	50.00%	10.39%
Wheat	**100%**	6.00%	73.00%		77.01%
Avocados	**100%**	76.00%		21.03%	4.83%
Pumpkins and courgettes	**100%**	14.00%		38.00%	4.10%
Tomatoes	**100%**	44.00%		44.90%	1.11%

Onions	**100%**	38.00%	81.01%	7.48%
Lemons	**100%**	85.00%	57.10%	11.6%
Apples	**100%**	58.00%	35.30%	12.17%
Oranges	**100%**	87.00%	22.03%	15.74%
Bananas	**100%**	43.00%	47.42%	0.11%

5.2 Calculation of the food loss percentage along the supply chain for each selected product

Once the matrix of loss percentages by supply chain stage is available, the total percentage of food losses along the supply chain is calculated for each selected food product. This calculation assumes that the loss percentage is available for all supply chain stages of each food product, l_{ej} ,as well as the total quantity of production reaching each stage of the chain, q_{ej} .It is assumed that, from the total quantity produced $q_j$of the selected food product j, the quantity q_{ej}reaches stage $e$of the supply chain, and its corresponding share is p_{ej}.
Based on this, the total food loss percentage along the supply chain of the selected crop $j$is defined as:

$$l_j = \sum l_{ej} \times \left(\frac{q_{ej}}{q_j}\right) = \sum l_{ej} \times p_{ej}$$

5.2.1 Example of information for aggregating food losses percentages along the chain (beans)

From the supply chain mappings, the percentage of national production that passes through the respective supply chain stage ($p_{ej} = \frac{q_{ej}}{q_j}$) is identified. This value is multiplied by the percentage losses of the respective supply chain stage and summed up to obtain the total loss percentage along the supply chain.

$$l_j = (4.8\% \times 100\%) + (5\% \times 90\%) + (1.8\% \times 70\%) + (4.5\% \times 50\%) + (3.6\% \times 10\%) = 13.2\%$$

		Farm	Collection center	Warehouse	Wholesaler	Processing
Loss percentage	$\boldsymbol{l_{ej}}$	**4.8%**	**5.0%**	**1.8%**	**4.5%**	**3.6%**

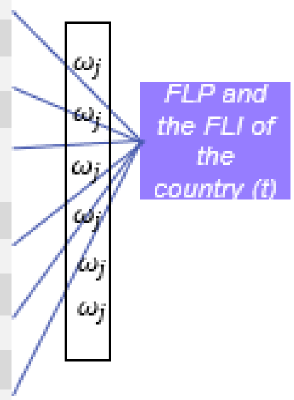
Percentage of the production volume handled	$\frac{q_{ej}}{q_j} = p_{ej}$	**100%**	**90%**	**70%**	**50%**	**10%**

5.3 Weighting matrix for aggregating food losses along the chain

To apply the calculation of the food loss percentage for 2019 set out in the methodology for SDG Sub-Indicator 12.3.1.a, the crop weights are multiplied by the food loss percentages for the whole supply chain, which results in a food loss percentage of the whole basket of 9.31 percent (Figure 2).

Figure 2. Weighted Calculation of the Food Loss Percentage for 2019 Based on Crop Weights and Supply Chain Loss Rates

	Farm (ENA 2019)	Collection center	Warehouse	Wholesaler	Processing plants	% Food losses along the supply chain
White maize	3.3	5.9	4.7		2.5	**9.2**
Beans	4.8	5.0	1.8	4.5	3.6	**13.3**
Wheat	0.4	2.4	3.4		1.8	**4.4**
Avocados	2.4	2.2		4		**4.9**
Pumpkins and courgettes	8.9	7.2		9.2		**13.4**
Tomatoes	1.4	7.3		7.3		**7.9**
Onions	3.2	9.3		5		**10.8**
Lemons	2.4	5.9		10.5		**13.4**
Apples	2	9.5		6.3		**9.7**
Oranges	8.7	7.5		9.7		**17.4**
Bananas	1.5	2.7		6.3		**5.6**



The methodology for SDG Sub-Indicator 12.3.1.a establishes a fixed weighting index in which each crop's weight is calculated based on its production value relative to the total value of production of the selected basket (or production plus imports when imports exceed 10 percent of production). These weights are calculated using national production, import, and price data—often based on FAOSTAT information and international average prices—with 2019 (2018–2020 average) used as the baseline year. Once established, the weights remain fixed for reporting purposes.

5.3.1 Crop weights and their aggregation to the Food Loss Index

The weighting system determines the relative importance of each crop's loss percentage within the overall Food Loss Index. As a result, commodities with higher production volumes, as well as high-value crops, carry greater influence in the overall loss percentage of the basket.

	Production in tons (+ imports)* (FAOSTAT average 2018–2020) q_{j0}	International price (USD, FAOSTAT) p_{j0}	Value $(q_{j0} * p_{j0})$	Crops weights $\frac{(q_{j0} * p_{j0})}{\sum_j (q_{j0} * p_{j0})} = \omega_{j0}$
White maize	27,274,056	207.3	5,652,597,335	**32.7%**
Beans	1,188,253	718.2	853,410,981	**4.9%**
Wheat	7,532,746	232.6	1,752,083,593	**10.1%**
Avocados	2,293,134	856.2	1,963,277,494	**11.3%**
Pumpkins and courgettes	784,710	276.6	217,068,297	**1.3%**
Tomatoes	4,322,877	467.7	2,021,631,375	**11.7%**
Onions	1,519,817	413.3	628,214,642	**3.6%**
Lemons	2,709,562	533.7	1,446,029,194	**8.4%**
Apples	972,362	462.1	449,341,517	**2.6%**
Oranges	4,707,775	324.6	1,527,925,349	**8.8%**
Bananas	2,406,047	331.2	796,893,040	**4.6%**
			$\sum_j (q_{j0} * p_{j0}) =$ 17,308,472,818	**100%**

White maize has the highest weight within the selected basket, accounting for 32.66 percent of the overall food loss percentage, followed by tomatoes, avocados and wheat. This means that losses in these crops have the greatest influence on the national Food Loss Index, while crops with lower production value, such as onions and apples, have less impact. The weights are calculated only for the baseline year and remain fixed in subsequent years to exclude production fluctuations and focus solely on changes in loss percentages. This approach enables consistent comparisons across crops, countries and years. Applying these fixed weights to the 2019 loss percentages results in an overall food loss percentage of 9.31 percent for the basket.

	Crop weighting factor used in the compilation of the FLP ***(calculated once and kept fixed for all reporting years)*** $\frac{(q_{j0} * p_{j0})}{\sum_j (q_0 * p_0)} = \omega_{j0}$	**% Food losses along the supply chain** ***(updated with each reporting year)*** l_{ij2019}
White maize	32.7%	9.2%
Beans	4.9%	13.3%
Wheat	10.1%	4.4%
Avocados	11.3%	4.9%
Pumpkins and courgettes	1.3%	13.4%
Tomatoes	11.7%	7.9%
Onions	3.6%	10.8%
Lemons	8.4%	13.4%
Apples	2.6%	9.7%
Oranges	8.8%	17.4%
Bananas	4.6%	5.6%
		FLP = 9.31%

*lj =9.2% * 32.7% + 13.3% * 4.9% + 4.4% * 10.1% +....+ 4.6% * 5.6% =* ***9.31%***

* These are not official results from the country-level loss indicator

6. Conclusion

The Food Loss Index (FLI) compilation exercise demonstrates that Mexico can estimate and report SDG Sub-Indicator 12.3.1.a using existing data sources, particularly the National Agricultural Survey (ENA) as the primary driver of farm-level loss monitoring. By combining dynamic farm-level data with fixed factors and synthetic estimates for off-farm stages, the methodology offers a pragmatic and cost-efficient medium-term solution in the absence of full supply chain measurement. A structured quality classification system allowed heterogeneous data sources to be integrated into a coherent framework, while supply chain mapping highlighted both the strengths of the national statistical system and remaining information gaps—especially beyond the farm gate.

The exercise confirms that monitoring can begin with at least one regularly measured stage and progressively expand as new data collection instruments are institutionalized. Future efforts should focus on updating the index regularly, improving farm-level measurement methodologies, and prioritizing systematic data collection for off-farm stages, particularly through instruments such as the Production, Marketing and Price Survey (EPCP). Overall, Mexico has established a scalable and transparent framework that provides a solid foundation for progressively strengthening food loss monitoring under SDG 12.3.1.a.

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