World Bank- Mexico

Food Losses and Food Waste in Mexico: quantification and some proposals for public policy

Genaro Aguilar Gutiérrez
World Bank consultant in Mexico

Objective

- Quantify food losses and food waste in Mexico through the formulation of a scientific methodology along with the implementation of a representative study in the State of Jalisco, to identify the main causes of the problem. Having identified the causes and magnitude, this study could be used for the implementation of public policies to address the problem in a better way.

Dimensions of the study

Quantitative: FL & FW volumes

Environmental: waste water and gas emissions for a food group

Economic and Social: measure the costs of FL & FW

1. Calculation of a Food losses and food waste Index in Mexico

The volumes of food losses and waste throughout the food chain are very high; this has implications for food security.

But, How big are these food losses?

It is therefore necessary to calculate the annual amount of food waste in Mexico and its environmental, social and economic impacts.

Methodology, formula and results of the quantification

Food losses and food waste in Mexico in 2014

A) Development of a formula (international studies, including FAO)

B) Data (ENIGH Household Expenditures Survey, SEDESOL, SAGARPA, SE)

We can define apparent domestic consumption of any food product as follows:

$$CNA_{i,t} = Y_{i,t} - X_{i,t} + M_{i,t}$$

Y = National Production of Food i, in the period t

X = National Exports of Food i, in the period t

M = National Importations of Food i, in the period t

However, we must subtract the product wasted in the producer-consumer chain to calculate the real consumption and waste:

$$D_{i,t} = CNA_{i,t} - CR_{i,t} \quad \text{.....(2)}$$

Where:

$D_{i,t}$ = is the national waste of the product *i* in period *t*;

$CR_{i,t}$= It is the real consumption of the product *i,* in period *t*

We can get an estimate of the real consumption of each product:

$$CR_{i,t} = c_{i,t}^{1} + c_{i,t}^{2} + c_{i,t}^{3} + \cdots + c_{i,t}^{4} \quad \text{.....(3)}$$

The consumed amount of a product is the aggregate of the quantities consumed person to person:

$$CR_{i,t} = \sum_{i=1}^{n} c_{i,t} \quad \text{.....(4)}$$

The consumption of each food within each household in Mexico, could be quantified by using the micro-data from the National Survey of Income and Expenditure (ENIGH).

$$D_{i,t} = CNA_{i,t} - \sum_{i=1}^{n} c_{i,t} \quad \text{.....(5)}$$

This formula is the food loss and food waste Index in Mexico.

More broadly, we need to quantify consumption in households, restaurants, schools, hotels, hospitals; and others.

In addition, we calculate the weight that each of these foods have in the diet of Mexicans.

The general formula of the Food Waste Index in Mexico is:

$$DN = \frac{D_{1,t}}{Ct}\frac{\pi_{1,t}}{1} + \frac{D_{2,t}}{Ct}\frac{\pi_{2,t}}{1} + \frac{D_{3,t}}{Ct}\frac{\pi_{3,t}}{1} + \frac{D_{4,t}}{Ct}\frac{\pi_{4,t}}{1} + \cdots + \frac{D_{k,t}}{Ct}\frac{\pi_{k,t}}{1}$$

where C_t is the total food intake of the Mexican population.

That is, the National Food Waste (DN) is a weighted sum of each food waste.

The weighting factor is the contribution of each food type in the diet of the Mexican population*

Basic data sources for calculating the national food waste and food losses are: a) the micro-data from the National Survey of Income and Expenditure in Households (ENIGH) in Mexico 2014; b) data consumption in Restaurants (restaurant industry); Hotels, Schools, Hospitals, Military installations (Defense); c) data for Apparent Domestic Consumption of food from the Agriculture Atlas 2015; SIAP (Information System of Agrifood and Fisheries by SAGARPA)

Main results: What is the level of food waste in Mexico?

Food	Weekly consumption in tons or m3	Annual consumption in tons / m3	Adding consumption in restaurants, hotels, schools, hospitals	Annual per capita consumption	Waste (tons)	Waste%
Tortilla	160,587	8,373,470	9,956,056	79.9	2,857,388	28.70
Beef	23,191	1,209,272	1,559,961	12.5	552,382	35.41
Pork	1,543	80,459	102,988	0.8	41,391	40.19
Ham	2,636	137,423	147,043	1.2	57,200	38.90
Chicken	15,716	819,489	926,023	7.4	275,955	29.80
Fish	4,589	239,294	256,044	2.1	99,115	38.71
Shrimp	451	23,512	31,271	0.3	15,257	48.79
Milk	164,586	8,584,800	10,645,152	85.4	4,590,189	43.12
Potatoes	37,244	1,943,789	2,079,854	16.7	788,057	37.89
Avocado	13,327	695,539	785,959	6.3	312,812	39.80
Tomato	34,232	1,784,964	2,356,153	18.9	925,968	39.30
Nopal	3,374	175,908	205,813	1.7	76,768	37.30
Mango	20,126	1,050,378	1,176,424	9.4	468,570	39.83
Apple and perón	9,186	478,988	560,416	4.5	218,170	38.93
Guava	2,962	154,449	168,349	1.4	63,687	37.83
Papaya	6,967	363,270	430,475	3.5	171,458	39.83
Baby food	170	8,872	10,380	0.1	3,426	33.00
Subtotal:					11,517,793	
Total					20,418,214	34.57

The total food loss and food waste in Mexico (for a group of 79 products representative of the Mexican diet) is more than 20.4 million tons per year.

What is the environmental impact of such food waste in Mexico?

The World Bank

2. Environmental impact

Product/Food	Waste (tons)	Waste %	Kg CO2e/kilo	Total CO2e (Kg)
Tortillas	2,857,388	28.70	0.564	1,611,566,803
Rice	249,372	37.20	2.7	673,304,516
Beef	552,382	35.41	18.2	10,053,355,155
Pork	41,391	40.19	8.13	336,507,572
Chicken	275,955	29.80	6.91	1,906,847,721
Milk	4,590,189	43.12	1.9	8,721,359,903
Cheese	154,637	36.78	8.6	1,329,877,379
Heavy Cream	47,521	27.93	5.2	247,108,525
Butter	5,520	23.10	0.73	4,029,754
Eggs	1,320,862	37.98	4.8	6,340,139,782
Potatoes	788,057	37.89	2.9	2,285,364,743
Elote	59,473	31.23	0.278	16,533,413
Beans	329,386	27.13	2	658,771,773
Tangerine	61,573	34.33	1.1	67,729,771
Mango	468,570	39.83	1.1	515,426,505
Apple	218,170	38.93	1.1	239,986,953
Melons	106,007	31.03	1.1	116,607,704
Orange	927,370	22.30	1.1	1,020,107,472
Papaya	171,458	39.83	1.1	188,603,979
Pear	26,704	31.23	1.1	29,373,922
Pineapple	50,926	29.30	1.1	56,018,987
Banana	281,336	38.30	1.1	309,470,089
Watemelon	77,246	28.30	1.1	84,970,977
Grapes	15,384	13.90	1.1	16,922,786
Juices and nectars packaged	188,249	29.30	0.3	56,474,684
	13,865,126	(34.57)		**36,886,460,870**

13,865,126 tons (of 29 products)

=

36,886,460,870 kilos CO2e

Carbon footprint or ecological footprint of food waste in Mexico

- A vehicle in good conditions emits on average per year, 2,500 kg of CO2e.
- CO2e emissions generated by the production of food that is wasted in Mexico, is equivalent to the annual emissions from 14,754,584 cars (all vehicles in DF and the states of Mexico, Jalisco and Nuevo Leon together)

3. Annual economic cost of carbon dioxide emissions for losses and food waste

	Waste (tons)	CO2e/ Kilo	Total CO2e (tons)	Cost (dollars by food)
Tortillas	2,857,388	0.56	1,611,567	$16,115,668.32
Rice	249,372	2.7	673,304	$6,733,044.00
Beef	552,382	18.2	10,053,352	$100,533,524.00
Porf	41,391	8.13	336,509	$3,365,088.30
Chicken	275,955	6.91	1,906,849	$19,068,490.50
Milk	4,590,189	1.9	8,721,359	$87,213,591.00
Chess	154,637	8.6	1,329,878	$13,298,782.00
Heavy cream	47,521	5.2	247,109	$2,471,092.00
Butter	5,520	0.73	4,030	$40,296.00
Eggs	1,320,862	4.8	6,340,138	$63,401,376.00
Potatoes	788,057	2.9	2,285,365	$22,853,653.00
Elote	59,473	0.29	16,533	$165,334.94
Beans	329,386	2	658,772	$6,587,720.00
Tangerine	61,573	1.1	67,730	$677,303.00
Mango	468,570	1.1	515,427	$5,154,270.00
Apple	218,170	1.1	239,987	$2,399,870.00
Melon	106,007	1.1	116,608	$1,166,077.00
Orange	927,370	1.1	1,020,107	$10,201,070.00
Papaya	171,458	1.1	188,604	$1,886,038.00
Pear	26,704	1.1	29,374	$293,744.00
Pineapple	50,926	1.1	56,019	$560,186.00
Banana	281,336	1.1	309,470	$3,094,696.00
Waterme	77,246	1.1	84,971	$849,706.00
Grapes	15,384	1.1	16,922	$169,224.00
Juices and nectars packa	188,249	0.3	56,475	$564,747.00
Total	13,865,126		36,886,459	$368,864,591.06

That is, the annual economic cost of carbon dioxide emissions for losses and food waste in Mexico is:

US$368,864,591

4. Environmental impact: Annual amount of water lost through waste food in Mexico (24 products)

Food	Water necessary / kilogram	Waste (tons)	Water wasted (liters)
Tortillas	900	2,857,388	2,571,649,153,828
Soups	27	115,863	3,128,311,699
Bread	5443.2	2,633,392	14,334,082,031,063
Rice	3400	249,372	847,864,945,978
Beef	15500	552,382	8,561,923,346,618
Pork	4800	41,391	198,676,057,166
Chicken	6000	275,955	1,655,728,846,376
Milk	1000	4,590,189	4,590,189,422,531
Eggs	3606	1,320,862	4,763,030,011,358
Potatoes	280	788,057	220,655,906,260
Elote	700	59,473	41,630,895
Tomato	180	925,968	166,674,259,102
Tangerine and nectarine	1200	61,573	73,887,022,768
Grapefruit	460	11,597	5,334,546,253
Mango	1600	468,570	749,711,280,473
Apple	700	218,170	152,718,969,854
Orange	460	927,370	426,590,397,326
Banana	860	281,336	241,949,342,558
Grapes	840	15,384	12,922,854,426
Sugar	1500	109,833	164,749,175,124
Coffee	980	14,749	14,454,354,215
Chocolate	24000	4,337	104,077,918,511
39,860,039,784			39,860,039,784,381

16,523,211 tons (24 foods)

=

39,860,039,784,381 liters of water

Ecological footprint of food waste in Mexico

According to the National Water Commission (2014), every Mexican home uses an average of 360 liters of water daily…

So, the water lost in a year due to food waste in Mexico could provide water, for one year, to

303,348,857 people!

(This is 2.4 times the current population of Mexico. Or, it could provide water to all Mexicans for 2.4 years).

5. Annual Economic Costs of water loss by food losses in Mexico

	Water loss by product (liters)	Cubic meters	Cost (at 0.20 dollars /m3)	Cost (at 0.80 dollars/m3)
Tortillas	2,571,649,153,828	2,571,649,154	514,329,831	2,057,319,323
Soups	3,128,311,699	3,128,312	625,662	2,502,649
Bread	14,334,082,031,063	14,334,082,031	2,866,816,406	11,467,265,625
Rice	847,864,945,978	847,864,946	169,572,989	678,291,957
Beef	8,561,923,346,618	8,561,923,347	1,712,384,669	6,849,538,677
Pork	198,676,057,166	198,676,057	39,735,211	158,940,846
Chicken	1,655,728,846,376	1,655,728,846	331,145,769	1,324,583,077
Milk	4,590,189,422,531	4,590,189,423	918,037,885	3,672,151,538
Eggs	4,763,030,011,358	4,763,030,011	952,606,002	3,810,424,009
Potatoes	220,655,906,260	220,655,906	44,131,181	176,524,725
Elote	41,630,895	41,631	8,326	33,305
Tomato	166,674,259,102	166,674,259	33,334,852	133,339,407
Tangerine	73,887,022,768	73,887,023	14,777,405	59,109,618
Grapefruit	5,334,546,253	5,334,546	1,066,909	4,267,637
Mango	749,711,280,473	749,711,280	149,942,256	599,769,024
Apple	152,718,969,854	152,718,970	30,543,794	122,175,176
Orange	426,590,397,326	426,590,397	85,318,079	341,272,318
Banana	241,949,342,558	241,949,343	48,389,869	193,559,474
Grapes	12,922,854,426	12,922,854	2,584,571	10,338,284
Sugar	164,749,175,124	164,749,175	32,949,835	131,799,340
Coffee	14,454,354,215	14,454,354	2,890,871	11,563,483
Chocolate	104,077,918,511	104,077,919	20,815,584	83,262,335
Total	39.860.039.784.381	39.860.039.784	**7.972.007.957**	31.888.031.828

The total cost of water loss by food losses in Mexico is

US$7,972,007,957

7.9 billions of dollars/year

What would be the income generated, if all the food wasted in Mexico was sold at market prices?

6. Annual Economic Costs of food losses in Mexico (market prices)

Food	Waste (kilos or liters)	Price / Kg (Mexican pesos)	Economic Loss in Mexican pesos (1000)	US dollars in thousands US$
Tortillas	2,857,388	11.0	$31,431,267.44	$2,328,242.03
Soups	115,863	22.1	$2,564,636.28	$189,973.06
Cockies	44,954	67.6	$3,040,687.88	$225,236.14
Bread	2,633,392	25.0	$65,834,812.39	$4,876,652.77
Rice	249,372	17.7	$4,413,885.16	$326,954.46
Cereals	50,661	76.7	$3,884,212.43	$287,719.44
Beef	552,382	127.5	$70,428,724.30	$5,216,942.54
Ground beef	77,534	120.0	$9,304,059.25	$689,189.57
Pork	41,391	85.3	$3,528,569.56	$261,375.52
Ham	57,200	140.0	$8,007,961.81	$593,182.36
Sausages	81,999	53.3	$4,372,595.28	$323,895.95
Chicken	275,955	53.5	$14,763,582.21	$1,093,598.68
Fish	99,115	103.5	$10,258,367.54	$759,879.08
Milk	4,590,189	15.0	$68,738,086.60	$5,091,710.12
Eggs	1,320,862	28.5	$37,644,579.96	$2,788,487.40
Potatoes	788,057	16.0	$12,608,908.93	$933,993.25
Total (79 products)			$491,116,863.67	$36,379,026.94

The annual economic cost of food losses in Mexico (market prices) is:

US$36,379,026.94

36 billion US dollars!

7. The social costs

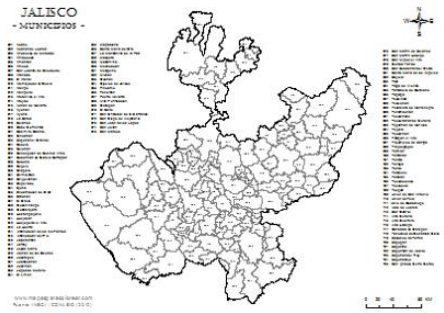
If all the food that is wasted in Mexico were recovered**, it could feed the entire Mexican hungry population**

7. Social Costs: Food that could be recovered and delivered to the poorest

Food	Waste (Kilos)	Kilos per poor person per year	Kilos per poor family/week
Tortillas	**2,857,387,949**	**249.72**	**19.21**
Beef	**552,382,151**	**48.28**	**3.71**
Ground beef	77,533,827	6.78	0.52
Pork	41,390,845	3.62	0.28
Chicken	275,954,808	24.12	1.86
Fish	99,114,662	8.66	0.67
Tuna	18,128,326	1.58	0.12
Shrimps	15,256,982	1.33	0.10
Milk	**4,590,189,423**	**401.16**	**30.86**
Eggs	**1,320,862,455**	**115.44**	**8.88**
Potatoes	788,056,808	68.87	5.30
Avocado	312,811,547	27.34	2.10
Tomatoes	925,968,106	80.92	6.22
Carrots	117,565,765	10.27	0.79
Beans	329,385,887	28.79	2.21
Lentils	24,531,151	2.14	0.16
Guava	63,686,572	5.57	0.43
Lemon	88,022,419	7.69	0.59
Mango	**468,569,550**	**40.95**	**3.15**
Apple	**218,169,957**	**19.07**	**1.47**
Melon	106,007,004	9.26	0.71
Papaya	171,458,163	14.98	1.15
Banana	**281,336,445**	**24.59**	**1.89**
Watermelon	77,246,343	6.75	0.52
Juices and nectars packaged	188,248,948	16.45	1.27
Baby cereal and baby food	3,425,508	0.30	0.02

8. Case Study: Jalisco, Mexico

Generator of food losses or food waste	number of respondents
Agricultural producers	56
Carriers	54
Supply Center (wholesale market; traders)	60
Retailers	60
Householders	60
Total	290



8. Some results of the field work: producers

¿En su proceso de producción se generan pérdidas o mermas de alimentos?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sí	48	84.2	85.7	85.7
	No	8	14.0	14.3	100.0
	Total	56	98.2	100.0	
Missing	System	1	1.8		
Total		57	100.0		

- In your production process are food losses generated?

Yes: 85.7%

No: 14.3%

8. Some results of the field work: producers

¿Cuáles son las causas por las que se ocasionan las pérdidas o mermas de lo que usted produce?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mala o deficiente planeación de la producción	2	3.5	4.3	4.3
	Falta de capacitación en el manejo	6	10.5	13.0	17.4
	Limitado conocimiento para la conservación y preservación	7	12.3	15.2	32.6
	Caracteristicas de los alimentos producidos	22	38.6	47.8	80.4
	Manejo inadecuado de los alimentos	9	15.8	19.6	100.0
	Total	46	80.7	100.0	
Missing	System	11	19.3		
Total		57	100.0		

- Causes of food losses according to producers:
- 1. Due to poor quality products (47.8%).
- 2. Due to lack of food preservation knowledge (15.2%).
- 3. Due to of lack training (13%).
- 4. Poor production planning (4.3%).

9. Main findings

- 1. There are high economic, environmental and social costs due to food losses and food waste.
- 2. There is insufficient infrastructure for adequate production, distribution and commercialization of food in Mexico.
- 3. Insufficient training for proper food handling.
- 4. Insufficient dynamism of the domestic market.
- 5. A National Strategy is needed to reduce losses and food waste.

10. Some proposals to reduce food losses in Mexico

- **Proposals**: Generate public policies throughout the chain value, which encourage every economic actor to play its role in a sustainable way, considering all the negative effects (environmental, economic and social) that generate these losses and wastage of food.

- These public policies also should take as a reference experiences that nowadays are working in the recovery of food wastage, such as the food bank and some others.

Thank you very much