Measurement Issues and Lessons Learned from Estimating Food Loss at the Retail and Consumer Levels in the USA

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ABSTRACT

In the United States, 31%—or 133 billion pounds—of the 430 billion pounds of the available food supply at the retail and consumer levels in 2010 went uneaten according to the Loss-Adjusted Food Availability (LAFA) data series from the U.S. Department of Agriculture's Economic Research Service (USDA/ERS). The estimated retail value of this food loss was $161.6 billion.ERS has undertaken a series of initiatives to improve the technical and measurement assumptions underlying the LAFA loss estimates, including sponsoring a workshop to inform its data and research planning on food availability and food loss. This paper shares lessons learned from these efforts and provides valuable information for researchers interested in measuring food loss. Key lessons learned include the difficulty of obtaining food loss data from the private sector and measuring the loss of raw commodities embedded in multi-ingredient foods.

Keywords: Food availability, Food Availability Data System (FADS), food waste, Loss-Adjusted Food Availability (LAFA) data series.

PAPER

1 INTRODUCTION

The Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) maintains the Loss-Adjusted Food Availability (LAFA) data series. The primary purpose of this series is to estimate the per capita daily calories and food pattern equivalents (i.e., "servings") for five major food groups (fruit, vegetables, grains, meat, and dairy) plus added sugars and sweeteners and added fats and oils. These estimates represent the food available for consumption as a proxy for actual intake.

ERS also uses the underlying loss assumptions in the LAFA data series to estimate the amount, value, and calories of food loss at the retail and consumer levels in the United States for around 215 commodities(e.g., beef, eggs, fresh apples, canned corn). Here, food loss represents the amount of food, post-farm-gate that is available for human consumption (i.e., does not include animal feed) but is not eaten for any reason. It includes cooking loss and natural shrinkage (e.g., moisture loss); loss from mold, pests, or inadequate climate control; and food waste. Consumer level loss estimates do not include inedible portions. The denominator for retail level food loss is the amount of food availability at the retail level and the denominator for consumer level food loss is the amount of food availability at the consumer level.

ERS estimates that in the United States, 31%—or 133 billion pounds—of the 430 billion pounds of the available food supply at the retail and consumer levels in 2010 went uneaten (Table 1)(Buzby et al., 2014). The food loss had an estimated retail value of $161.6 billion and equaled 141 trillion calories annually, or 1,249 calories per capita per day. One-third of these losses, or 43 billion pounds, were in grocery stores and other retailers, and two-thirds, or almost 90 billion pounds, occurred in homes, restaurants, and other away-from home eating places. Had losses on-farm and between the farm gate and retail level been included, total food loss nationally would have been greater.

Measuring food loss in the United States has recently gained new importance following the September 16, 2015 announcement of a new Food Waste Reduction Goal by USDA and the U.S. Environmental Protection Agency (EPA), which aims to reduce total food waste in the U.S. by 50% by 2030(USDA, 2015). This paper advances knowledge and understanding of the measurement and technical challenges of estimating food loss with a focus on loss at the retail and consumer levels. In recent years, ERS has undertaken a series of initiatives to improve the technical and measurement assumptions underlying the LAFA loss estimates, and in 2014 sponsored a workshop to inform its data and research planning on food availability and food loss (NRC and IOM, 2015). This paper shares lessons learned from these efforts and provides valuable information for researchers interested in measuring food loss and its food waste subcomponent. The LAFA data series is considered preliminary because ERS has initiatives underway to further refine the data series.

Table 1 - Estimated Food Loss in the United States, 2010

Commodity	Food Supply[a]	Retail Level Losses		Consumer Level Loss		Total	
	Billion Pounds	*Billion Pounds*	*Percent*	*Billion Pounds*	*Percent*	*Billion Pounds*	*Percent*
Grain products	60.4	7.2	12	11.3	19	18.5	31
Fruit	64.3	6.0	9	12.5	19	18.4	29
Vegetables	83.9	7.0	8	18.2	22	25.2	30
Dairy products	83.0	9.3	11	16.2	20	25.4	31
Meat, poultry, and fish	58.4	2.7	5	12.7	22	15.3	26
Eggs	9.8	0.7	7	2.1	21	2.8	28
Tree nuts and peanuts	3.5	0.2	6	0.3	9	0.5	15
Added sugar and sweeteners	40.8	4.5	11	12.3	30	16.7	41
Added fats and oils	26.0	5.4	21	4.5	17	9.9	38
Total	430.0	43.0	10	89.9	21	132.9	31

[a] Food supply at the retail level, which is the foundation for the retail- and consumer-level loss stages in the LAFA data series. Totals may not add due to rounding. Source: Buzby et al.(2014).

2. FOOD AVAILABILITYDATA SYSTEM

The ERS' Food Availability Data System (FADS)is an important and useful resource for assessing the country's ability to provide healthy diets, and for evaluating policy changes and interventions aimed at improving diets (Krebs-Smith in NRC and IOM(2015), p. 61).The core series in the system, the Food Availability (FA) data series is based on supply and use balance sheets, which provide estimates of the supply of around 215 commodities or foods available for consumption in the United States. For a given year and commodity, the supply of that commodity is the sum of production, imports, and beginning stocks (i.e., inventories). From this amount, ERS subtracts out exports, farm and industrial uses, and ending stocks to estimate the amount available for consumption. Per capita estimates for a commodity are calculated by dividing the total annual availability by the U.S. population for that year. The data system relies on annual measures of U.S. agricultural production and stocks at the farm level from the USDA's National Agricultural Statistics Service (NASS) and on estimates of U.S. imports and exports from the U.S. Census Bureau' trade data. The data to estimate farm and industrial (non-food) use, if available, come from a variety of sources depending on the commodity, and include products used on the farm for feed, seed, or industrial uses, such as ethanol or biofuels.

Because the FA data series overstates the amount of food actually eaten by capturing substantial quantities of food lost to human consumption(e.g., spoilage, plate waste) beyond the farm gate in the marketing system, in foodservice outlets and restaurants, and in the home, ERS created the LAFA series, which adjusts the FA data for loss at three levels:

- 1) Primary: Farm gate to retail (e.g., during transport, processing, and wholesaling);
- 2) Retail: Supermarket losses (e.g., dented cans, unpurchased holiday foods, spoilage, and the culling of blemished or misshaped foods);
- 3) Consumer: Losses of food consumed at home and away from home (e.g., in restaurants, fast-food outlets, schools and other institutions). This loss includes cooking loss and uneaten food, such as plate waste from the edible share.[For selected commodities (e.g., produce), the series also removes the non edible share of a food (e.g., apple cores, asparagus stalks) at this stage. Other commodities have inedible portions removed at the primary level (e.g., boneless meat, poultry, and seafood)].

For each LAFA commodity, retail and consumer level food losses are measured by multiplying the per capita quantity of that commodity available for consumption by a loss factor. Per capita loss estimates are multiplied by the U.S. population and summed by food group.

3. LESSONS LEARNED FROM INITIATIVES TO UPDATE ERS'S FOOD LOSS ASSUMPTIONS

ERS's long-run goal is to provide the best estimates of food availability (as a proxy for actual consumption) possible given available resources. A key component of that goal has been to increase the rigor and reliability of the LAFA data series through a series of initiatives to improve the technical and measurement assumptions underlying the LAFA loss estimates. This has been challenging due to resource limitations, the diverse nature of the three types of food loss assumptions in LAFA, and the complexity of the U.S. food system. To date, ERS has completed several initiatives to update the three types of loss assumptions for many of the 200 plus commodities in the LAFA data series. Data from two of the initiatives, which measured losses at the retail and consumer levels, are now used directly in the LAFA data series. Select data from a third initiative, which measured farm-gate to retail losses, are used by ERS commodity analysts in the FADS supply and use balance sheets.

3.1 Losses at the primary level (farm gate to retail)

In 2003, ERS and the University of Minnesota's Food Industry Center (TFIC) compiled revised agricultural conversion factors from the farm gate to the retail level, which described how a farm commodity (e.g., fresh chicken) is transformed into a consumer-ready product (e.g., boneless fresh chicken). Using information from a series of industry interviews, TFIC updated conversion factors for major meats and poultry commodities, and for several fruits and vegetables.In 2007, researchers from Pennsylvania State University and the International Life Sciences Institute (ILSI) built on the TFIC work under a new cooperative agreement with ERS. They reviewed the TFIC estimates, collected data on the remaining commodities not covered by TFIC (e.g., grains, fats, and dairy products), and explored additional areas of concern.

Lessons learned:

- One identified area of concern is how well the FA supply and balance sheets account for the increased amount of some commodities (e.g., chicken) going to pet food use.
- It is very difficult to produce reliable national farm to retail conversion factors or food loss estimates for individual commodities given the size and diversity of the U.S. farm and food processing sector, the wide range of commodities, and diverse growing regions, as well as year-to-year variation in weather (e.g., drought, floods), pest infestation, and farm animal and plant diseases. Some of these may affect the quality of the commodities and hence, ultimately, the post-farm gate shelf life of individual products.
- Even if farmers, processors, and others collected this information, concerns about losing competitive advantage may preclude them from publically releasing the data;
- For some commodities, like baby carrots, production is too concentrated in a small number of firms to report data without disclosing information on individual firms.

3.2 Losses at the retail level

In September 2007, ERS obtained 2005-06 food loss estimate sat the retail level (e.g., from supermarkets) for fresh fruits, vegetables, meat, poultry, and seafood through a competitive grant with the Perishables Group, Inc. (PG). For individual fresh fruits and vegetables, PG compared supplier shipment data with corresponding point-of-sale data (with both types of data aggregated across all stores and retailers in the sample) from stores in supermarket retail chains to identify shrink, which was later used as a proxy for food loss in LAFA. The sample provided estimates for over 600 retail stores from 6 national or regional chains in all 4 U.S. regions (East, South, Central, and West). Supermarket shrink for fresh meat, poultry, and seafood was estimated via interviews with a small sample of retail executives due to a lack of reliable supplier shipment data for these foods. The updated loss estimates were incorporated into LAFA in February 2009 and are documented in Buzby et al.(2009).PG did not have appropriate data to update the retail-level loss assumptions for other LAFA commodities, including added fats and oils, added sugars and sweeteners, dairy products, grain products, and processed fruits and vegetables (e.g., canned, frozen, dried/dehydrated, and juice).

More recently, ERS repeated the study for the same commodities with PG, now known as the Nielsen Perishables Group (NPG), and obtained 2011 and 2012 shrink estimates for the same individual fresh foods(Buzby et al., 2015, Buzby et al., Forthcoming). This study had greater coverage: roughly 2,900 stores from 5 retail chains (one large national and four regional supermarket retailers). These stores were located in 45 states plus the District of Columbia (DC). The same method was used for individual fresh fruits and vegetables (i.e., supplier shipment data was compared with point-of-sale data to estimate shrink). Unlike the previous study, shrink was estimated directly for fresh meat, poultry, and seafood, but only for case-ready, Universal Product Code (UPC)-coded items. Data were not available for random-weight items.For perspective, a National Meat Case Study found that the estimated share of case ready, UPC-coded fresh meat and poultry was 66% of the market in 2010 (SealedAir/BCP/NPB, 2010).

Lessons learned:

- Supermarket shrink for fresh meat, poultry, and seafood is difficult to estimate due to a lack of reliable supplier shipment data. In the United States, a significant share of fresh meat is delivered to grocery stores in carcass portions, which are later butchered in-store into retail-size cuts and sold as random weight;
- Using UPC-coded data alone to estimate shrink for fresh meat, poultry, and seafood is not appropriate due to a lack of data on random weight items, which account for a significant share of total product sales;
- Comparing shipment to point-of-sale data to estimate shrink is not appropriate for many FADS commodities (e.g. flour) that are primarily consumed as multi-ingredient foods (e.g. bread, cookies). As most foods that people eat are mixtures (Moshfegh in NRC and IOM(2015), p. 83), a method that starts with foods as eaten and works backwards (i.e., fork to farm) would require the use of recipes to break down these foods into commodity ingredients to estimate food loss;
- Further retail-level research is needed to:

- estimate shrink for the other commodities in LAFA;
- determine the extent to which shrink captures an unknown amount of theft, accounting errors, and other factors;
- determine if shrink is dependent on the assortment offered for sale, including the variety of products of a particular commodity at different value levels (e.g., lower-, average-, and higher-priced bagged spinach or salad greens) (Buzby et al., 2015)(p. 644); and
- determine if shrink varies by store type (e.g., megastores, convenience stores, supermarkets).

3.3 Losses at the consumer level

Under a grant with ERS, RTI International (henceforth RTI) generated new consumer-level loss factors for the majority of the LAFA commodities (Muth et al., 2011).First, RTI reviewed existing studies on consumer-level food loss and interviewed a small sample of restaurant managers(Muth et al., 2007). Next, they calculated household food loss by comparing household food purchase data (Nielsen Homescan data) with at home dietary intake data from the National Health and Nutrition Examination Survey (NHANES). ERS then analyzed the impact of the proposed RTI loss factors on the LAFA data series(Muth et al., 2011). In August 2012, ERS incorporated most of RTI's „best estimates" of consumer-level food loss (where available) in the LAFA data series.

Lessons Learned:

- Comparing food purchase with intake data is challenging for LAFA commodities typically consumed as multi-ingredient foods (e.g., wheat and rye flour consumed as breads, cookies, rolls, and pasta).
- Sample sizes were too small for some commodities (e.g., rye flour, corn starch, and select fruit juices) to calculate accurate loss factors.
- Methods are needed to estimate food loss for individual foods consumed away from home (i.e., in restaurants, fast-food outlets, and schools).Currently, the LAFA data do not distinguish food loss (or food availability) at home versus away from home. Some food loss is likely greater in away from home settings (e.g., plate waste in restaurants due to larger portion sizes)(Muth et al., 2011).
- Nationally representative data are not available to analyze consumer-level food loss patterns by demographic or regional groups (e.g., level of education; rural vs. urban; age).

4. OTHER MEASUREMENT ISSUES AND CHALLENGES

In 2013, ERS contracted with the National Research Council (NRC) and the Institute of Medicine (IOM) of the National Academies to organize a workshop to advance knowledge and understanding of the technical and measurement issues of the Food Availability data series, the LAFA data series, and the LAFA food loss factors so that the data can be maintained and improved (NRC and IOM, 2015). As a result, a day-and-a-half workshop was held April 8-9, 2014 in Washington DC. Some of the measurement issues and challenges discussed include:

- **FADS relies on continuous, high-quality national, annual data at different points of the farm gate to fork chain**. Most time-series data rely on a steady stream of high-quality, national, and annual data. However, researchers cannot always anticipate, or control, data shortfalls. For example, in 2011, the Census Bureau discontinued select Current Industrial Reports (CIR), which provided FADS data for added fats and oils (except butter), durum flour, and candy and other confectionery products. Therefore, 2010 is the last year that FADS data are available for these commodities. Subsequently, NASS developed the Current Agricultural Industrial Reports (CAIR) data series to collect data on specific manufactured products in key agricultural industries. ERS plans to incorporate the CAIR estimates in FADS.
- **Food loss factors are not refined enough to vary over time (in most cases)**. In LAFA, the food loss factors for individual foods and levels are the same for the entire data series range (i.e., 1970 to the most recent year), with few exceptions. For example, one exception is that beef conversion factors have changed over time to reflect greater trimming of fat when transforming meat from carcass to boneless weight.
- **Food donations are not directly measured**. FADS doesn"t adequately reflect food donations (e.g., at the retail level to food banks and other charitable organizations) or the transfers of unsold food in retail stores to thrift shops for sale at lower prices. Donated food ultimately eaten by people should not be counted as food loss.
- **FADS import and export data do not reflect the growth of multi-ingredient foods**. An increasing share of U.S. food trade is in the form of multi-ingredient or processed foods (e.g., vegetable beef soup). However, trade data in the FADS is mainly commodity-based (e.g., beef). This is an increasingly important issue to address. The Food and Agriculture Organization (FAO) is also confronted with this problem in

their food balance sheet system, which has data for around 185 countries or territories for more than 80 primary commodities plus 10 commodity groups, though not all commodities are produced or consumed in every country (Schmidhuber in NRC and IOM(2015), pgs. 68, 71). Methods need to be developed to account for the commodity portion of multi-ingredient foods in trade data.

▪ **Various definitions complicate comparisons of studies worldwide and the estimation of new loss factors**. Definitions of food loss and waste differ widely across studies worldwide, complicating the comparison of estimates and the identification of trends across the supply chain, U.S. localities, and internationally(Buzby & Hyman, 2012). Not only are there different definitions of the measured variable (e.g., shrink, food loss, and food waste) but studies may also use different points of reference and different areas of coverage in the analyses (Buzby et al., 2015).

5. CONCLUSION

To date, ERS has updated and explored food loss estimates with an ad hoc approach for various commodities and marketing levels (i.e., primary, retail, and consumer), rather than updating the data simultaneously. The underlying estimates are derived from several sources (e.g., NASS, Census, and the aforementioned food loss initiatives). Currently, probability distributions or other measures of variation are not reported. ERS plans to obtain such measures in future food loss research initiatives. For example, in April 2016, ERS contracted with RTI to update food loss factors for the consumer level.

Moving forward, ERS will have many decisions to make about whether and how to integrate any new loss factors into the LAFA data series (e.g., whether to adopt them for the entire time span of 1970 to the most recent year available). Currently, the FADS data are a valuable resource for assessing the country's ability to provide healthy diets to the population, and for evaluating policy changes and interventions meant to improve nutrition and health. Improved accuracy and precision of the food loss assumptions underlying the LAFA data will improve the data's usefulness to researchers and policymakers. Once further improvements are made, the LAFA data series can be used as an important foundation for analyzing the national „food loss foodprint," such as the amounts of CO2, water, and energy equivalents embedded in the food lost to human consumption in the United States in a given year. To date, Venkat(2012) has used the LAFA data to analyze the climate change and economic impacts of food waste in the United States. However, other measures of the societal burden of food loss could help target private and public sector actions to address food loss.

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