

Industrial Food Processing Waste Analyses

U.S. Environmental Protection Agency

Office of Resource Conservation and Recovery

December 2012

EPA's contractor was tasked with performing a waste generation and management analysis of industrial food processing waste. Given the broad range of food processing industry sectors and the number of different waste streams generated (a search of NAICS showed hundreds of codes for food processors), the contractor targeted a subset of food processing industries that comprise a larger percentage of the overall food waste stream as compared to other food processing industries and that are rich in organic materials. Specifically, the contractor assessed the fruit, vegetable, meat, dairy, and brewery sectors, as specified in our work plan.

According to USDA, fresh and processed fruits and vegetables, fluid dairy products, and meat (including poultry and fish) made up almost 55 percent of the food loss in 1995.¹ The remaining 45 percent of food loss is from grain products, caloric sweeteners, fats and oils, and a category of "other" foods (including eggs, peanuts, tree nuts, dry beans, peas, and lentils, and dairy products other than fluid milk). In addition to targeting fruits, vegetables, dairy and meat industries, we added the brewery sector since its wastes are rich in organic material and are good candidates for recovery via composting or anaerobic digestion.

The purpose of this analysis is to provide a summary of the data sources and available waste generation and management information for each of the five targeted industrial sectors.

Data Sources

To perform the analysis, the team researched available data, contacting industry associations representing the individual sectors and state associations in states that have the largest concentrations of the sectors selected for analysis. In addition, the team performed a literature search (including profile articles in *BioCycle*), to obtain data on industrial food waste generation and management.

Waste Generation

National sources of waste generation data were sought for the targeted food processing sectors. We identified national level waste generation data for fruits, vegetables, and meat and limited waste generation data and information for the brewery and dairy sectors.

The U.S. Department of Agriculture (USDA) Economic Research Service (ERS) developed a

¹ USDA 1997. *Estimating and Addressing America's Food Losses*. January-April 1997. www.ers.usda.gov/Publications/FoodReview/Jan1997/Jan97a.pdf.

2011 report, *Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data*, spreadsheets, and documentation in support of that report.² The contractor used a subset of the full ERS dataset. The USDA ERS food availability data are calculated at three different levels:

- Primary level: farm to retail (including food processing);
- Retail level: supermarkets, grocery stores and other retail outlets (not including restaurants and other foodservice outlets);
- Consumer level: food consumed at home and away from home (for example, at restaurants and cafeterias) by consumers and food services. This category includes nonedible portions of food, such as banana peels or apple cores, and cooking loss and uneaten food, such as plate waste.

The ERS data quantifies food availability; the contractor used the ERS data to capture the calculated loss within that data system. For this analysis, loss at the primary level is equal to the difference between the weight at the primary level and the weight at the retail level. The contractor has assumed that the food loss at the primary level represents food processing loss.

As listed in an article published in *Food Policy Journal*, causes of food loss on-farm and between the farm and retailer in developed countries include:

- Damage by insects, rodents, birds or microbes as well as damage by unfavorable or extreme weather;
- Spillage and damage caused either by equipment malfunction or inefficiencies during harvesting, drying, milling, transporting or processing;
- Diminishing returns when harvesting additional increments of production and other factors leading to leaving some edible crops unharvested;
- By-products from food processing not diverted to other food uses (e.g., ingredients); and
- Out-grading of blemished, misshapen or wrong-sized foods due to quality standards of buyers.³

Although this list of causes includes more than food processing losses, the ERS dataset has insufficient detail to separate out the food processing losses from the non-processing losses. Therefore, the contractor assumed all losses at the primary level were from food processing.

The multiple causes of loss at the primary production level factor into the difficulty of quantifying the amount of food processing waste generated in the U.S. Non-processing losses, influenced by weather and pest factors, vary from year to year. As noted in the *Food Policy Journal* article⁴, the USDA was not able to estimate primary losses from all food products due to data limitations. USDA food loss estimates were available for four of the five target sectors

² Muth, Mary K., Shawn A. Karns, Samara Joy Nielsen, Jean C. Buzby, and Hodan Farah Wells. *Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data*, TB-1927, USDA/ERS. January 2011.

³ Buzby, Jean and Jeffrey Hyman. Total and per capital value of food loss in the United States. *Food Policy* 37 (2012), 561-570. Table 1.

⁴ Idem.

(fruit, vegetable, dairy, and meat).

The contractor excluded USDA reported liquid food loss from the analysis when possible; liquid food loss (such as fluid dairy products) is not considered solid waste for the purposes of this analysis. Liquid food waste is assumed to enter into the wastewater system. All USDA food losses reported for the dairy sector were liquid losses.

The contractor contacted industry groups and experts to identify additional waste generation data. The primary data sources contacted were the Washington Department of Ecology and Washington State University, the National Renderers Association, the Innovation Center for US Dairy, Wisconsin Department of Natural Resources, Brewers of Europe, and the Beer Institute.

Waste Management

No sources of national waste management data were identified for the five sectors. It is important to note that the USDA ERS data represent food availability and loss; no information was available on the ultimate management of the food lost. The contractor performed literature searches and contacted industry groups and experts to help determine the waste management practices in each of the sectors. Sources contacted included the Grocery Manufacturers Association,⁵ the United Fresh Produce Association, Florida Citrus Processors Association, California League of Food Processors, Northwest Food Processors Association, the Innovation Center for US Dairy, the National Renderers Association, and breweries.

Based on information the contractor collected from industry groups and experts, only a small portion of food loss may be land disposed because much of the waste is beneficially utilized (e.g., processed into other products, fed to animals, used as fertilizer, etc.). Due to increased market demand or technology improvements some materials previously considered waste are now saleable by-products. Whey created during cheese manufacture is a prime example of a former waste stream that is now used to create other products.

Waste Generation

The collected waste generation information is summarized below for each of the targeted food waste sectors.

Fruit and Vegetables

Fruit and vegetable industrial solid waste include items removed from fruits and vegetables during cleaning, processing, cooking, and/or packaging. These items may include leaves, peels, pomace, skins, rinds, cores, pits, pulp, stems, seeds, twigs, and spoiled fruits and vegetables.

⁵ In 2007, the Food Products Association (FPA) merged with the Grocery Manufacturers Association (GMA). The FPA (formerly the National Food Processors Association) was the principal scientific and technical U.S. trade association representing the food products industry. GMA's 200 company membership represents all of the major national or international food and beverage companies.

Using the USDA ERS data, the contractor developed an estimate of the amount of fruit and vegetable food waste per capita that occurs at the industrial level, as shown in Table 1. The contractor estimated the tons of food waste per year by multiplying the per capita loss to the U.S. population and converting to tons (where 2,000 lbs = 1 ton).

Table 1. Fruit and Vegetable Sectors Industrial Food Waste

Year	Industrial Food Waste ¹ (Pounds per Capita per Year)		U.S. Population ³ (1,000)	Industrial Food Waste ⁴ (1,000 Tons per Year)	
	Fruit ²	Vegetables ²		Fruits	Vegetables
2000	65.10	133.10	282,168	9,184	18,778
2001	63.47	129.45	285,050	9,045	18,450
2002	60.25	130.26	287,746	8,668	18,740
2003	61.45	133.12	290,242	8,918	19,318
2004	61.90	132.09	292,936	9,066	19,347
2005	58.12	130.42	295,618	8,590	19,277
2006	55.60	125.86	298,432	8,296	18,780
2007	52.60	127.98	301,394	7,927	19,286
2008	50.25	122.11	304,177	7,643	18,571
2009	51.03	123.04	306,656	7,825	18,866

(1) Primary to Retail Loss, Non-MSW industrial/process. Includes process waste from fruit juice production (assumed solid waste).

(2) USDA ERS. The ERS Food Availability Data System Loss Adjusted Food Availability data tables. Downloaded July 2012. [http://ers.usda.gov/data-products/food-availability-\(per-capita\)-data-system.aspx#26705](http://ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx#26705)

(3) U.S. Census Bureau, Population Division. Table 1. Preliminary Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010 (NST-PEST2010-01) Release Date: February 2011

(4) Pounds per capita times U.S. population converted to tons.

The contractor identified one regional source of fruit and vegetable waste generation measurement. The data are available from a biomass assessment conducted in Washington State by the Washington Department of Ecology and Washington State University and presented in the report titled, “Biomass Inventory and Bioenergy Assessment: An Evaluation of Organic Material Resources for Bioenergy Production in Washington State, December, 2005”.⁶ In addition to the final report, a web accessible computer database complete with GIS maps on a Visual Basic platform is available.⁷ The study and online database aimed to inventory Washington’s field residues, animal manures, forestry residues, food packing/processing waste, and municipal wastes are good examples of tools developed to promote reduction of organic materials disposal to the solid waste stream.

Meat

According to the National Renderers Association, in partnership with the Animal Protein Producers Industry Committee and the Fats and Proteins Research Foundation, the U.S. livestock

⁶ Fuchs, M.R. and C. Frear, et. Al. Biomass Inventory and Bioenergy Assessment: An Evaluation of Organic Material Resources for Bioenergy Production in Washington State; December 2005 (Revised April 2011). 05-07-047.

⁷ Pacific Biomass. <http://www.pacificbiomass.org>

sector slaughters more than 150 million head of cattle, calves, hogs and sheep and more than 55 billion pounds of poultry annually.⁸

Solid waste from the meat processing and rendering sector is comprised primarily of slaughterhouse waste. Wastewater from a slaughterhouse can contain blood, manure, hair, fat, feathers and bones (manure is a solid waste product of the meat sector, but is not discussed in this analysis). The quantity of waste generated and the characteristics of the waste depend on the kind of meat being processed.

The contractor used the USDA ERS dataset to estimate industrial food waste in the meat sector, as shown in Table 2. The contractor estimated the tons of food waste per year by multiplying the per capita loss to the U.S. population and converting to tons (where 2,000 lbs = 1 ton).

Table 2. Meat Sector Industrial Food Waste

Year	Meat Sector Industrial Food Waste ^{1,2} (Pounds per Capita per Year)	U.S. Population ³ (1,000)	Meat Sector Industrial Food Waste ⁴ (1,000 Tons per Year)
2000	90.35	282,168	12,747
2001	89.21	285,050	12,715
2002	92.27	287,746	13,275
2003	91.52	290,242	13,281
2004	92.91	292,936	13,608
2005	92.83	295,618	13,721
2006	93.02	298,432	13,880
2007	92.61	301,394	13,956
2008	90.09	304,177	13,702
2009	87.66	306,656	13,440

(1) Primary to Retail Loss, Non-MSW industrial/process.

(2) USDA ERS. The ERS Food Availability Data System Loss Adjusted Food Availability data tables. Downloaded July 2012. [http://ers.usda.gov/data-products/food-availability-\(per-capita\)-data-system.aspx#26705](http://ers.usda.gov/data-products/food-availability-(per-capita)-data-system.aspx#26705)

(3) U.S. Census Bureau, Population Division. Table 1. Preliminary Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010 (NST-PEST2010-01) Release Date: February 2011

(4) Pounds per capita times U.S. population converted to tons.

The majority of slaughterhouse wastes are processed through renderers into saleable by-products. This relationship is described in more detail in the Meat Waste Management section.

Dairy

The USDA ERS data do not include any solid wastes for the industrial dairy sector; only liquid wastes were estimated for the industrial dairy sector. The contractor's contact with dairy industry groups and experts confirm these data; the majority of waste is liquid and the majority of by-products are utilized.

⁸ Jekanowski, Mark. "Survey Says: A Snapshot of Rendering," Tech Topics. Render, pp. 58-61, April 2011

According to data in the 2011 US Dairy Sustainability Report, 192.8 billion gallons of milk were produced in 2010 and 195.8 billion pounds of dairy products were produced from this milk. The milk is used commercially as follows: 43 percent is used in cheese production; 23 percent for fluid milk; and 17 percent for other products including butter (7 percent), nonfat dry milk (5 percent) and frozen products (5 percent).⁹

The 2011 US Dairy Sustainability Report does not include national data on the quantity of residuals generated from milk processing and dairy product production. According to the Food Processing Environmental Assistance Center at Purdue University, little solid waste is generated during dairy processing; wastewater is the primary “waste” output. In a personal communication with an industry expert, it was confirmed that at the processor level, “most of the waste is in liquid form, somewhere between 60 to 95 percent water.”¹⁰

The contractor’s literature search provided some additional insight. For example, a 1998 report from the Wisconsin Department of Natural Resources¹¹ noted that cheesemaking typically starts with whole pasteurized milk, of which 10 percent actually becomes cheese, and 90 percent is a liquid by-product known as whey. Whey was previously disposed of, but today whey is processed into additional products. Industry experts stated that the “dairy industry is pretty good about extracting value out of all products/by-products.... Once the milk is turned into a product, any residuals usually are used in some way, e.g., cheese scraps reused in processed cheese, and off-spec or old product ends up in feed.” The same expert noted that any manufacturing by-products not currently recovered and used are likely due to the fact that the cost to haul what is primarily water is more than the value of the by-product to be hauled.¹⁰

Breweries

Spent brewer’s grain and brewer’s yeast are the two primary solid wastes (by-products) of the beer brewing process. A recently released study by the Brewers of Europe, “The Environmental Performance of the European Brewing Sector”¹² defines these brewery “by-products” as follows: “Brewers’ grains comprise the materials which remain after starch has been solubilized from grains. Brewers’ yeast is used for fermenting beer and during the fermentation process the yeast multiplies several times. A portion of this is reused in subsequent fermentations but large amounts remain available for other uses”. Other by-products include spent brewer’s hops and trub (proteins) which are formed at different stages of brewing, and diatomaceous earth slurry which results from the filtration of beer. Although the majority of these by-products may be repurposed (as discussed under Waste Management), a portion of them are ultimately disposed.

⁹ 2011 U.S. Dairy Sustainability Report, Innovation Center for U.S. Dairy.
<http://www.usdairy.com/Sustainability/Measurement/Pages/Reporting.aspx>.

¹⁰ Personal Communication, Washington Consulting, Informa Economics, October 17, 2012.

¹¹ Rodenberg, Jerry. Waste Management Issues For Dairy Processors. Bureau of Cooperative Environmental Assistance, Wisconsin Department of Natural Resources, 1998.

¹² Donoghue, C., G. Jackson, J.H. Koop and A.J.M. Heuven. The Environmental Performance of the European Brewing Sector. The Brewers of Europe, May 2012

According to the Beer Institute, a total of 194,169,303 million barrels of beer were produced in the U.S. in 2010 (one barrel = 31 gallons).¹³ No national data are available on the total quantity of solid waste generated by U.S. breweries. Brewery data were not included in the USDA ERS report.

The contractor identified a waste generation metric noted in the New Belgium Brewing's *2011 Waste Diversion Report*. This report stated that the brewery created 2.14 lbs of waste for each barrel of beer produced; 0.12 lbs of this waste was landfilled.¹⁴ Using these estimates and brewery production data, the contractor estimated the quantity of waste generated by breweries in the U.S., as shown in Table 3. Management of these wastes by landfilling is presented in the next section.

Table 3. Brewery Sector Industrial Food Waste

Year	Malt Beverage Production (Million Barrels per Year)¹	Brewery Sector Industrial Food Waste ² (Tons per Year)
2000	199	212,930
2001	199	212,930
2002	198	211,860
2003	195	208,650
2004	198	211,860
2005	197	210,790
2006	198	211,860
2007	198	211,860
2008	197	210,790
2009	197	210,790
2010	194	207,580

1) Beer Institute. www.beerinstitute.org

2) Calculated by multiplying production by assumed value of 2.14 pounds of waste per barrel and converted to tons. Where 2,000 lbs = 1 ton.

Waste Management

National data on solid waste management for the five food processing sectors are not available either from the industry associations or in the literature. However anecdotal information, as well as confirmation from the industry associations, indicates that the majority of solid wastes from these food processing sectors are utilized in some manner. The primary methods of utilization are: animal feed; raw material for another food product or industrial/consumer product; and direct utilization on agricultural land.

Fruits and Vegetables

In terms of management of fruit and vegetable food processing waste streams, the contractor's

¹³ Beer Institute. www.beerinstitute.org

¹⁴ Rich, Alie. New Belgium Brewing 2011 Waste Diversion Report.

<http://www.newbelgium.com/files/sustainability/2011%20nbb%20waste%20diverion%20report.pdf>

personal communications (as noted below) as well as anecdotal citations in individual company reports leads to the general conclusion that a very high percentage of the solid waste streams from fruit and vegetable processing are utilized versus disposed. Utilization includes animal feed, production of another food or industrial/consumer product, direct utilization on agricultural land, composting and anaerobic digestion (sometimes followed by composting). In the contractor's personal communication with a waste management consultant for the food processing industry,¹⁵ it was noted that due to the severe drought in the Midwest in the summer of 2012, fruit and vegetable wastes from the production level are in high demand for use as animal feed.

California is among the highest fruit and vegetable producing states in the country. In the contractor's personal communication with California League of Food Processors (CLFP) CLFP's executive director, it was stated that "very little organic material from fruit and vegetable processing plants ends up in landfills. Almost all of it is recycled as animal feed, composted, or used as a soil amendment. All of those uses create value for the end user."¹⁶

As another example, the Florida Citrus Processors Association (FCPA) provided estimates of juice residuals management to the Florida Department of Citrus. The FCPA stated that the quantities vary from plant to plant and season to season and variety to variety. However, the FCPA provided an example of 100 tons of fruit processed resulting in 61 tons of juice and pulp; 38 tons going to feed; and 1 ton being used for essential oils. In this example, no waste is landfilled.¹⁷

Anecdotal information included the following, found on the website of the Northwest Food Processors Association, which links to various members' sustainability reports:

- Kettle Food: "None of Kettle Foods' agricultural waste enters the waste stream. Everything from uncooked corn and raw potatoes to finished potato chips that don't make the grade goes to companies that use it either for composting or for animal feed."¹⁸
- Simplot: "Today, with a second generation of a family-led business, sustainability at Simplot is much more complex - from reclaiming potato processing by-products for the production of methane gas, to transforming potato waste starch into animal feed for our feedlots. The essence, however, has remained the same: To work in smarter, more cost-efficient ways and to reduce and reclaim resource-use throughout our operations. By-products from a number of our food processing and fertilizer plants are used to provide water and nutrients to neighboring farms. This "land application" of by-products is managed to meet the agronomic needs of the crop being grown. We have installed anaerobic digesters at our Aberdeen, Moses Lake and Portage La Prairie processing plants to capture the biogas from potato by-products and pipe it into the plants' boiler systems. In 2008, we began using oil from our french fry facilities to create biodiesel

¹⁵ Personal Communication, William Deaton, Member, Deaton & Associates, LLC; October 16, 2012

¹⁶ Personal Communication, Rob Neenan, President/CEO, California League of Food Processors, October 16, 2012.

¹⁷ Personal Communication, Karen Mathis, Public Relations Director, Florida Department of Citrus, October 22, 2012.

¹⁸ Kettle Foods Sustainability Initiatives, <http://www.nwfpa.org/advocacy/sustainability/reports>

for use in our transportation and mining equipment, creating 100,000 gallons of cleaner-burning biodiesel.”¹⁹

Meat

In 2010, the National Renderers Association, in partnership with the Animal Protein Producers Industry Committee and the Fats and Proteins Research Foundation, contracted with Informa Economics to develop an updated industry profile — including descriptions of raw material streams and markets. A summary of the profile was published in the April 2011 issue of *Render* magazine.²⁰ The report stated that in addition to meat for human consumption, by-products are repurposed into “nearly 20 billion pounds of highly valuable feed and industrial products in the form of various types of fats and proteins.” The report states:

- “Livestock slaughter by-products, restaurant grease and scraps from grocery stores and butcher shops comprise the three primary raw material streams processed by renderers. The total volume of these raw materials processed is estimated at 48.32 billion pounds in 2010.” About 91 percent (44 billion pounds) are slaughter by-products.²¹
- The majority of rendered products are proteins, fats, greases, and tallow that are used in animal feed rations.

The “Meat Processing and Rendering” section of the World Bank Group’s 1998 “Pollution Prevention and Abatement Handbook” has some industry metrics regarding the solid waste stream from this sector. It states the following: “All slaughtering wastes (generally, 35% of the animal weight) can be used as by-products or for rendering. The only significant solid waste going for disposal is the manure from animal transport and handling areas.”²²

Based on the rendering industry assessment, the contractor believes that a very small percentage of the solid waste generated by meat processing is disposed.

Dairy

Because there is no solid waste estimated for the industrial dairy sector, there is no discussion needed of waste management for this sector. As noted earlier, there is no solid waste because the by-products are used to produce other products and any waste produced is wastewater.

¹⁹ J.R. Simplot Sustainability Summary 2010, <http://www.nwfpa.org/advocacy/sustainability/reports>

²⁰ Jekanowski, Mark. “Survey Says: A Snapshot of Rendering,” Tech Topics. *Render*, pp. 58-61, April 2011 (www.rendermagazine.com)

²¹ This is a quote from the reference; note that pounds are not a measure of volume. In addition, note that the reported amount of slaughter by-products exceeds the amount of USDA meat food loss in Table 2, due to differences in the estimation methodologies including the exclusion of edible offals (organs, blood, etc.) from the USDA food loss data.

²² World Bank Group: Meat Processing and Rendering. Pollution Prevention and Abatement Handbook. 1998.

Breweries

The contractor reviewed sustainability reports from several U.S. brewers to determine how the by-products/solid wastes from the brewing process are managed. The following provides a snapshot:

- **New Belgium Brewing:** The company’s 2011 Waste Diversion Report notes that its landfill diversion rates are: Spent grain: 94.34% that is diverted to local farms; Sludge: 3.5%; Recycled: 1.92%; Landfilled: 0.12%; Composted: 0.09%. As stated earlier, this report states that the brewery created 2.14 lbs of waste for each barrel of beer produced and 0.12 lbs of this waste were landfilled. While not directly stated, it appears that the spent grain is diverted to local farms for animal feed.²³ Using the estimated pounds per barrel landfilled (0.12 pounds), the following can be estimated from the Beer Institute’s statistics.

Table 4. Brewery Sector Industrial Food Waste Landfilled

Year	Malt Beverage Production (Million Barrels per Year) ¹	Waste Landfilled ² (Tons per Year)
2000	199	11,940
2001	199	11,940
2002	198	11,880
2003	195	11,700
2004	198	11,880
2005	197	11,820
2006	198	11,880
2007	198	11,880
2008	197	11,820
2009	197	11,820
2010	194	11,640

1) Beer Institute. www.beerinstitute.org

2) Calculated by multiplying production by assumed value of 0.12 pounds of waste per barrel and converted to tons. Where 2,000 lbs = 1 ton.

- **Sierra Nevada:** A 2009 article in *BioCycle*, “Anaerobic Treatment, Fuel Cell At Brewery,” reported that Sierra Nevada produces 750,000 barrels of beer annually. In 2010, a total of 33,772 tons of spent grain and yeast were diverted to animal feed.²⁴
- **MillerCoors:** In its 2011 Sustainability Report, MillerCoors states the following: “We reuse or recycle more than 99 percent of our brewery waste, from the protein-rich residual brewer’s grain and spent yeast to glass cullet, aluminum, plastic, wood and other materials. We turn “waste” into energy, compost and soil conditioner for our own use. We send the remaining by-products to companies that use them for many other beneficial purposes. For instance, by-products from our Albany Brewery are used to fertilize crops on an on-site 600-acre hay farm and 700-acre tree farm. Our Golden Brewery was the

²³ Rich, Alie. New Belgium Brewing 2011 Waste Diversion Report. <http://www.newbelgium.com/files/sustainability/2011%20nbb%20waste%20diverion%20report.pdf>

²⁴ Gekas, Katherine. Anaerobic Treatment, Fuel Cell At Brewery *BioCycle* Vol. 50, No. 1, 42-43.

nation's first major brewery to supply the feedstock that a third-party uses to manufacture pure ethanol—which is then used to power flex fuel vehicles.”²⁵

Based on these summaries, the brewery industry diverts as much solid waste as possible into usable by-products.

²⁵ Miller-Coors 2011 Sustainability Report; <http://www.millercoors.com/Great-Beer-Great-Responsibility/Environmental-Stewardship/Waste-Reduction.aspx>