

Consumer Food Waste: Environmental Impacts and Changing Course



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Consumer Food Waste: Environmental Impacts and Changing Course

Executive Summary

Millions of tons of edible food are wasted around the world and in the U.S. each year. Although the issue of food waste has received considerable publicity in recent years, much less attention has been given to the environmental impacts of producing edible food that is subsequently not eaten.

Food waste at the consumer level constitutes about twenty percent of total estimated food loss and waste; however, the loss of edible food once it reaches the intended ultimate consumer has a much higher environmental impact because all of the inputs required to produce, harvest, transport, process, and distribute food are embodied in food that reaches the consumer-level whether or not that food is eaten.

Based on an extensive review of literature regarding food loss and waste, and particularly household food waste in the United States, this report summarizes findings of environmental assessments of food waste at the consumer level. Suggestions as to how household food waste can be reduced are also provided.

Definitions of Food Loss and Waste

Estimates of the quantity of food waste generated nationally and globally vary widely, with the differences largely due to differences in definitions of what constitutes food waste. Some studies of food waste, for example, include in accounting of “waste” the non-edible (by humans) parts of food, such as banana and melon peels, bones, and egg shells. Other studies consider waste to include only that portion of food that humans can eat.¹ Estimation is further complicated by the scope of activity included in waste estimates. Some estimates may include only that waste of edible food that occurs at food retailers and in homes, while others may also consider food loss and waste that occurs in food processing plants, while still others may consider losses throughout the food chain, including losses in agricultural fields.

This report focuses on edible food waste that occurs on the part of individual consumers as a consequence of shopping habits, eating away from home, and preparing and storing food within the household.

The distinction between “food loss” and “food waste” is a bit subtle. As explained by the World Resources Institute (WRI)², the term “food loss” is used to describe removal of food material from the farm-to-consumer food chain due to such things as spills, spoilage, bruising or wilting. WRI notes that such losses most commonly occur in the course of production, storage, processing, or distribution. The term “food waste”, on the other hand, is used to describe food that is of good quality and fit for consumption, but which as a result of negligence or conscious decision, winds up

¹ Corrado and Serenella (2018)

² World Resources Institute (2013)

being discarded rather than consumed. Examples of food waste include unsold and discarded food in retail stores, a half-eaten meal that is left on the plate at a restaurant, bread that is discarded because it is stale, discarded bread crusts, sour milk poured down the drain, vegetables thrown out due to appearance, spoilage or mold, and carrot or potato peels generated in the course of processing, preparation, cooking, or serving of food.³ Such waste most often occurs at the retail and consumption stages (i.e. grocery retailers, restaurants, households) of the food value chain.⁴

Put more succinctly, food waste is, in the words of the European Court of Auditors, “any product or part of a product grown, caught or processed for human consumption that could have been eaten if handled or stored differently.”⁵

This report focuses on edible food waste that occurs on the part of individual consumers as a consequence of shopping habits, eating away from home, and preparing and storing food within the household. Steps that individual consumers can take to reduce food waste are identified. Also presented is information regarding the scope of food loss and waste throughout national and global food chains.

To produce the quantity of edible food that is produced, but not eaten (wasted) in the United States each year is estimated to require the following:

- 30 million acres (12.1 million ha) of cropland,
- 4.2 trillion gallons (15.9 billion m³) of irrigation water,
- 780 million pounds (354 million kg) of pesticides,
- 1.8 billion pounds (816 million kg) of Nitrogen fertilizer,
- 1.5 billion pounds (680 million kg) of phosphorous,
- 2.3 billion pounds of potash (1,043 million kg),
- 300 million barrels of oil

Source: All estimates except oil requirements from Conrad et al. (2018). Estimate of oil consumption linked to wasted food from Hall et al. (2009).

Scope of the Food Loss and Waste Problem

Global Overview

According to the Food and Agricultural Organization of the United Nations,⁶ about one third of the food produced for human consumption worldwide – approximately 1.4 billion tons (1.3 billion mt) each year – is lost or wasted. When expressed in terms of food value, this quantity of food

³ Food Waste Reduction Alliance (2016), FoodPrint (2017), USEPA (2017)

⁴ World Resources Institute (2013)

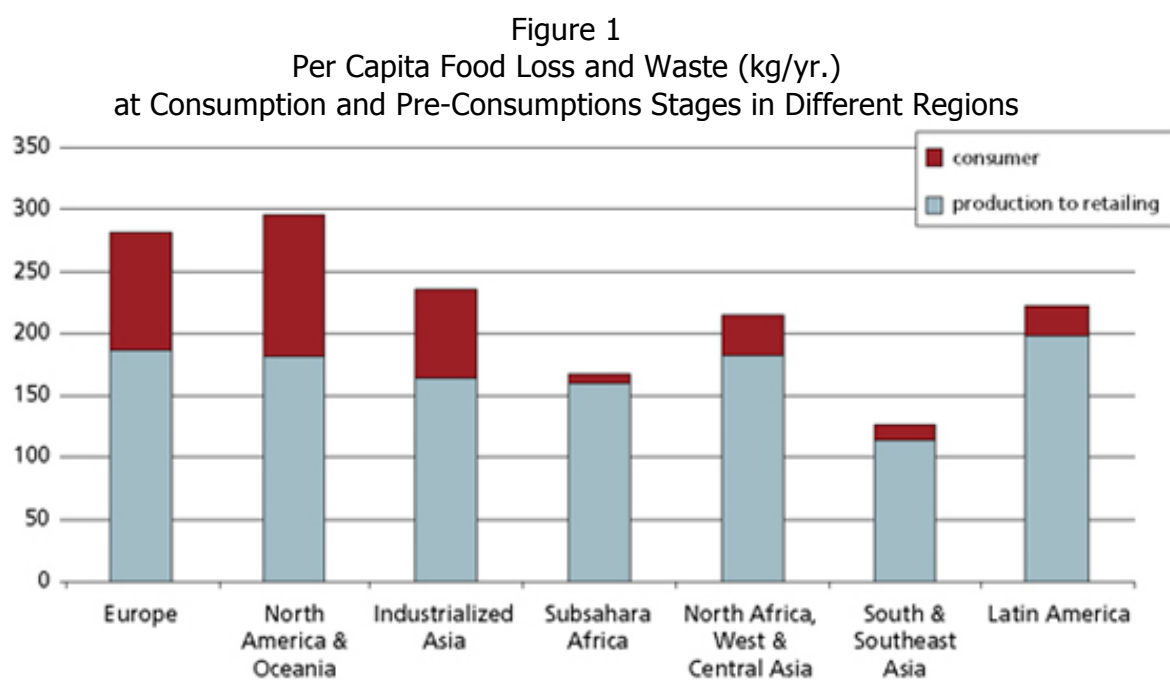
⁵ European Court of Auditors (2016)

⁶ FAO (2019)

constitutes about 24% of all calories produced for human consumption.⁷ Substantial loss and waste is reported in every country.

The FAO further reports that

- Fruits and vegetables, including roots and tubers, have the highest rates of loss and waste – 40-50%.
- Global quantitative food loss and waste rates are roughly 30% for cereals, 20% for meat, dairy, and oil seeds (soybeans, sunflowers, canola), and 35% for fish.
- At the retail level, large quantities of food are wasted due to quality standards that over-emphasize appearance.
- Per capita food loss and waste at the consumer level is 209-254 pounds (95-115 kg) annually in Europe and North America, whereas in south and south-eastern Asia, and sub-Saharan Africa, per capita waste is far lower – 13-24 pounds (6-11 kg) per year (Figure 1).



Source: FAO (2019)

North America

A 2017 study conducted by the Canadian-based Commission for Environmental Cooperation⁸ found that approximately 185 million tons (168 million mt) of food loss and waste are generated in North America each year. This figure, which includes all loss and waste from pre-harvest losses through waste at the consumer level, equates at the country level to:

- 139 million tons (126 mill. mt) total, and 915 pounds (415 kg)/person/yr in the U.S.
- 14 million tons (13 mill. mt) total, and 873 pounds (396 kg)/person/yr in Canada
- 31 million tons (28 mill. mt) total, and 549 pounds (249 kg)/person/year in Mexico.

⁷ Lipinski et al. (2013)

⁸ CEC (2017)

United States

A 2009 study⁹, which estimated food waste by evaluating average food energy intake in the U.S. vs. the energy value of the food supply, resulted in a 30-40% U.S. food waste estimate. The following year, a second study provided an estimate of food waste in the U.S.¹⁰, again in the 30-40% range. This estimate was based on a study of post-harvest food loss and waste, which found 21% of edible food wasted at the consumer level and another 10% at the retail level, yielding a consumer/retail level food loss estimate of 66.5 million tons (60.3 million mt) annually, with a value of \$161.6 billion. More recent numbers (2018) from the U.S. Environmental Protection Agency (EPA) indicate that about 94% of the food thrown away in the U.S. ends up in landfills or combustion facilities, and that the weight of food deposited in landfills or burned for energy in 2015 totaled 37.6 million tons (34.1 million mt).¹¹ The estimate did not include food loss at earlier stages of the food chain. Another study that used slightly different study boundaries and waste definitions, and which examined food waste in three US cities¹², estimated waste at the consumer level at 33-54% of total waste.

A USDA-funded investigation¹³ which focused only on consumer-level waste in the United States, and the implications of that waste in previous stages of the food chain, reported that food waste accounts for 30% of daily calories, and one-quarter of daily food (by weight), available for consumption. Waste estimates from this study were considerably higher than those reported by the EPA. Various estimates of food waste, which vary by as much as 50%, can be difficult to compare since procedures and things measured do not always match up. Nonetheless, all estimates point to extremely large volumes of food waste.

Canada

The Commission for Environmental Cooperation (CEC) study cited previously¹⁴ found very similar per-capita food loss/waste figures for Canada and the United States. However, studies of where within the food chain waste was occurring have suggested a much higher rate of loss at the consumer level in Canada. For example, several well-publicized reports have indicated that about half of food loss (47%) in Canada occurs at the household level.¹⁵ Using the CEC estimate of 14 million tons of total food loss and waste in Canada, and assuming 47% as household waste yields a total household food waste estimate of 7.3 million tons (6.6 million mt).

In contrast to earlier investigations, a 2019 study which broadened the scope of investigation to include close consideration of pre-harvest and early post-harvest stages in the food chain, concluded that only 14% of food waste occurs at the household level.¹⁶ In this case, household food waste in Canada was estimated at 5.6 million tons (5.1 million mt) annually, 16% lower than that determined by the CEC. As in the United States, despite inconsistency of findings, household food waste estimates indicate large quantities of food waste.

⁹ Hall et al. (2009)

¹⁰ Buzby et al. (2014)

¹¹ USEPA (2018a)

¹² Hoover (2017)

¹³ Conrad et al. (2018)

¹⁴ CEC (2017)

¹⁵ Gooch et al. (2010), Toronto Food Policy Council (2014)

¹⁶ Gooch et al. (2019), Gooch et al. study summary by Hui (2019)

Europe

Approximately 97 million tons (88 mt) of food are wasted in the European Union each year.¹⁷ The European Commission reports that more than half of that food waste occurs at the household level,¹⁸ a figure that is in agreement with determinations made by FAO Europe and Fusions 2 (Table 1). While several other prominent studies have found a lower proportion of household food loss (28-41%), the household losses by any estimate are again substantial.

Table 1
Share of Food Waste in the EU at Various Stages of the Food Supply Chain
(in % as reported in different studies)

| | FAO Europe | Foodspill (Finland) | FH Münster (Germany) | Bio Intelligence Service (EU) | Fusions 2 (EU) |
|-------------------|------------|---------------------|----------------------|-------------------------------|----------------|
| Production | 23 | 19-23 | 22 | 34.2 | 11 |
| Processing | 17 | 17-20 | 36 | 19.5 | 19 |
| Retail | 9 | 30-32 | 3 | 5.1 | 17 |
| Consumer | 52 | 28-31 | 40 | 41.2 | 53 |

Source: European Court of Auditors (2014)

Significance of Food Waste at the Consumer Level

Although food waste at the consumer level constitutes only one-seventh to one-fifth (14-20%) of total estimated food loss and waste based on food weight, the loss of edible food once it reaches the intended ultimate consumer has a much higher environmental impact than the percentage of mass would suggest. This is because all of the inputs required to produce, harvest, transport, process, and distribute food are embodied in edible food that reaches the consumer-level whether that food is eaten or not.

Consumer-level food waste is also significant in that relatively minor changes in consumer behavior could markedly reduce wastage of food that has gone all the way through the food chain, and reduce as well associated impacts. A change in consumer habits could also reduce the price of food, since consumers ultimately pay for all of the wasted food throughout the product chain. The reality that food waste reduction also yields consumer benefits enhances the solvability of this problem.

Food Loss and Waste Specifics

Understanding where waste occurs in the food chain, what exactly is lost, and reasons for the occurrence of loss, is necessary to the development of effective strategies to effect change. A number of investigations in various countries have examined this question, with all in close agreement. A 2014 report by the USDA Economic Research Service¹⁹ provided detailed information about annual food loss/waste at the retail and consumer (household) levels in the United States. As noted earlier, losses at the retail and consumer levels in the U.S. were found to account for 31 percent of post-harvest food loss, with two-thirds of this at the consumer level. As all other studies

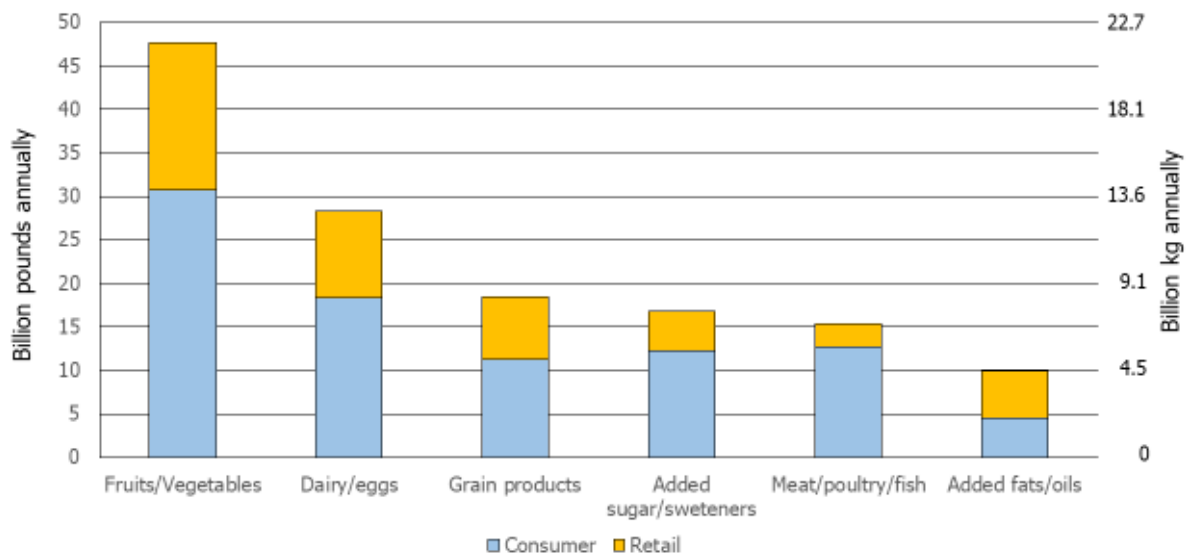
¹⁷ Stenmarck et al. (2016)

¹⁸ European Commission (2018)

¹⁹ Buzby et al. (2014)

have shown, fruits and vegetables are the greatest source of loss, followed by dairy products and eggs (Figure 2). In all categories, with the exception of added fats and oils, losses were greater at the consumer rather than retail level.

Figure 2
Estimated Annual Food Loss in the United States at the Consumer and Retail Levels, 2010



Source: Derived from USDA Economic Research Service (Buzby et al.) (2014)

Individual Consumers and Retail Food Waste

While much of food waste that occurs within restaurants is a result of management practices and decisions, the individual consumer also contributes to food wastage. For instance, as indicated in various reports,²⁰ diners at restaurants leave, on average, 17% of meals uneaten, with 55% of these potential leftovers not taken home. Moreover, even when food is boxed up and taken home, 38% is never eaten, resulting in waste not only of the food, but of the container as well.

Contributing to food waste is a significant increase in portion sizes at restaurants over recent decades. Investigation has shown, for example, that from 1982 to 2002, the number of calories in an average pizza slice increased by 70 percent, doubled in an average chicken Caesar salad, and quadrupled in an average chocolate chip cookie.²¹ A 2016 study by Tufts University Human Nutrition Research Center, which involved analysis of the calorie content of most commonly ordered meals at both local and large-chain restaurants in Boston, San Francisco, and Little Rock, found that 92% of 364 meals assessed exceeded recommended calorie intake for an entire day. In some cases, the daily recommended calorific intake was exceeded in a single meal serving even when not counting beverage, appetizer, or dessert.²²

²⁰ Gunders (2017), Hoover (2017)

²¹ Gunders (2017)

²² Urban et al. (2016)

Household Food Waste

The FoodPrint organization lists five major contributors to household food waste:²³

Food Spoilage

An estimated two-thirds of food waste at home occurs because food is not used before it spoils. Improper storage, lack of visibility in refrigerators and freezers, and misjudged food needs contribute to spoilage.

Over-Preparing

A third of household food waste is attributed to cooking or serving too much food. Shunning or neglecting to eat leftovers, exacerbates over-preparation and results in food discards.

Date Label Confusion

Studies show that a majority of Americans prematurely discard food due to confusion over the meaning of date labels such as “sell by,” “best if used by,” and “expires by.” In fact, “sell by” and “use by” dates only serve as manufacturer suggestions for peak quality, and do not indicate when food should not be consumed. Consumer confusion on this issue results in substantial discard of edible food.

Overbuying

Lower unit prices or sales on bulk purchasing can cause consumers to over-buy, especially when bulk purchases involve items prone to rapid deterioration. Spoilage and discard is often the result.

Poor Planning

Examples of poor planning include grocery store visits without first making a list of needed items – resulting in overstocking, and making unplanned restaurant visits or food takeout decisions that may cause food in the home refrigerator or cupboard to go bad before it is eaten.

We have added one more category to the list – purposeful waste.

Purposeful Waste of Bread Crusts

Advocates of bread waste are not hard to find. In some circles, serving sandwiches without crusts is the “in” thing to do. In others, cutting off crusts is promoted in the name of reducing calories. One recent television spot¹ revealed a “secret” for cutting calories: simply removing the crusts of bread, viewers were told, “cuts away approximately 40% of ‘bread calories’”. What viewers weren’t told is that cutting away crusts and discarding end slices also removes 20-30% of the volume of bread. The same calorie-cutting result could be achieved by simply cutting a slice of bread in half and using the two halves to make a sandwich.

Producing a loaf of bread involves field cultivation, planting, fertilization, and growing of wheat, harvest and threshing, transport, grading, storage, screening, washing, grinding, screening, sifting, adding bleaching and oxidizing agents, testing, packaging, shipment to a bakery, mixing with margarine, sugar, salt, yeast, and water to make dough, kneading, forming, baking, packaging, and shipment to a retail store, with energy expended at every step along the way. Transport from retailer to home consumes more energy. So when a significant part of a loaf of bread is simply discarded, what is discarded as well are all of the inputs that went into creating that volume of food. Discards then degrade resulting in additional impacts.

Research by the North London Waste Authority (NLWA) revealed that each year the equivalent of 13 million loaves of bread are thrown away in the form of crusts just within the city of London.^{*} The study found that 15% of consumers shun the heels of bread loaves and 43% routinely throw away crusts. Nationwide, it is estimated that the equivalent of 50 million loaves of bread are discarded rather than eaten in the UK every year.¹ A similar problem has recently been widely publicized in Germany.

* North London Waste Authority (2019)

²³ FoodPrint (2017)

Purposeful Waste

A prime example of purposeful food waste can be found in bread eating habits. Throwing the end slices of a loaf of bread in the trash, removal of crusts from sandwich bread before eating, or simply eating out the middle of a slice of bread and trashing the rest, all serve to illustrate needless, avoidable food waste (see text box on the previous page).

Although the magnitude of bread crust waste in the United States has not yet become a focus of attention, it is likely that waste volumes are large. And, as noted, such waste is completely avoidable.

Environmental Impacts of Food Waste

The USDA-funded study cited previously, which found food loss to amount to 30% of daily calories and one-quarter of daily available food, also examined the inputs needed to produce this large volume of uneaten food.²⁴ That report found that in addition to the waste of edible food, ongoing food loss also results in unnecessary farming of 30 million acres (12.1 million ha) and use of 4.2 trillion gallons (5,900 million m³) of irrigation water, 780 million pounds (354 million kg) of pesticides, 1.8 billion pounds (816 million kg) of nitrogen fertilizer, 1.5 billion pounds (680 million kg) of phosphorous, and 2.3 billion pounds (1,043 million kg) of potash. These estimates are also portrayed in the text box on page 4 of this report.

An earlier study²⁵ concluded that U.S. production of food not eaten also required consumption of about 300 million barrels of oil. A study by McKinsey consulting found²⁶ that, on average, household food losses are responsible for eight times the energy waste of farm-level food losses due to the energy used along the food supply chain and in preparation. Energy consumption, in turn, results in greenhouse gas (GHG) emissions. These figures do not include inputs at intermediate stages of the food chain.

Ultimately, uneaten food must be disposed of. The problem with landfilling, other than the reality of waste, is that landfilled food decomposes, emitting GHG emissions in the process. Emissions are largely in the form of methane, a GHG with more than 25 times the potency of CO₂.

The loss of edible food once it reaches the intended ultimate consumer has a much higher environmental impact than the percentage of mass would suggest. This is because all of the inputs required to produce, harvest, transport, process, and distribute food are embodied in that food whether that food is eaten or not.

Reducing Food Waste

The U.S. Environmental Protection Agency has developed a number of suggestions for reducing household food waste.²⁷ Suggested strategies involve attention to planning of food purchases, storing food, food preparation, and what are called thriftiness tips. Reducing food wastes can have

²⁴ Conrad et al. (2018)

²⁵ Hall et al. (2009)

²⁶ Dobbs et al. (2011)

²⁷ USEPA (2018b)

a significant impact on a family budget, as various estimates place the value of household food waste for a family of four at about \$2,000/year.

The following list of food waste strategies is based on EPA suggestions.

Planning Tips

Before shopping, make a list with weekly meals in mind.

- Prior to leaving for the grocery store, check the refrigerator, freezer, and cupboards to see what is already on hand and what may need to be used up within the coming week.
- Purchase in bulk only if you will be reasonably able to use the food before it spoils. (If you buy more than you need, and the result is discard of edible food, what may have looked like a bargain at the store almost certainly wasn't.)

Storage Tips

Store food appropriately.

- Store fruits and vegetables for maximum freshness as they will taste better and last longer, avoiding unnecessary waste.
- Freeze, preserve, or can surplus fruits and vegetables - especially abundant seasonal produce.
- Many fruits give off natural gases as they ripen, making other nearby produce spoil faster. Store bananas, apples, and tomatoes by themselves, and store fruits and vegetables in different bins.
- Wait to wash berries until you want to eat them in order to prevent mold.
- If you like to eat fruit at room temperature, but it should be stored in the refrigerator for maximum freshness, each morning take out only what you plan to eat for the day.

Food Preparation Tips

Prepare perishable foods soon after shopping.

- When arriving home from the store, take the time to wash, dry, chop, dice, slice, and place fresh food items in clear storage containers for snacks and easy cooking.
- Freeze foods that you know you won't be able to eat within the near future.
- Prepare and freeze meals ahead of time.

Thriftiness Tips

Make use of old ingredients and leftovers from previous meals.

- Cook or eat what you already have at home before buying more food.
- Produce that is past its prime or leftovers may be suitable for use in cooking, such as in soups, casseroles, stir fries, frittatas, sauces, baked goods, or smoothies.
- If safe and healthy, use the edible parts of food that you normally do not eat. For example, stale bread can be used to make croutons, beet tops can be sautéed for a side dish, and vegetable scraps can be made into stock.
- Learn the difference between "sell-by," "use-by," "best-by," and expiration dates.
- Plan an "eat the leftovers" night each week.
- Search for websites that provide suggestions for using leftover ingredients.

- At restaurants, order only what you can finish by asking about portion sizes and be aware of side dishes included with entrees. If you have leftovers, take them home and keep them for or to make your next meal.
- At all-you-can-eat buffets, take only what you can eat.

Keeping Food Waste Out of the Landfill

When, despite best efforts to minimize food waste, edible foods nonetheless wind up uneaten, there are several things that can be done to keep such waste out of the landfill. Common strategies are composting, composting with energy recovery, combustion with energy recovery, and use as feed for livestock for on-farm consumption.

Composting and Energy Recovery

The simplest form of composting is use of backyard composting bins for disposal and degradation of food scraps and other biodegradable materials. Natural degradation is accelerated by spontaneous heating within a compost pile, which ultimately results in rich organic matter used as a soil conditioner.

On a larger scale, food wastes and other compostable materials are collected curbside and transported to large-scale facilities where anaerobic digestion is used to generate biogas while preserving nutrients within the composted material. Biogas is used to generate heat and/or power, while the nutrient-rich remaining material is sold as fertilizer for use in agriculture. Food wastes can be treated in combination with sewage to create energy, and may be combined with other available organic wastes such as cow manure, poultry litter, and crop residues.²⁸

The city of Philadelphia has implemented a different approach, in which in-sink food disposal systems are used as a primary method of food waste collection. Disposal systems are required by law to be installed in new homes, with existing water treatment infrastructure then employed to recover organic solids for energy recovery prior to water treatment and recycling.²⁹ In-home garbage disposal systems convert food scraps into a slurry that passes through wastewater pipes and sewers. At the water resource recovery facilities, organics are recovered for processing into biogas and fertilizer products in anaerobic digesters. A pilot test found that this kind of system reduced food waste by an average of 35 percent.

As of 2012, there were reportedly about 800 industrial-scale waste to energy plants in more than three dozen countries, as well as perhaps thousands of smaller systems at individual sites.³⁰ Most of these plants used anaerobic digesters for conversion of organic waste into a fuels ranging from biogas to biodiesel or ethanol. In some cities, such as Minneapolis, Minnesota, USA, organic wastes are combusted to create steam that powers a major portion of the buildings in the center of the city.³¹

²⁸ Zafar (2016)

²⁹ Gerlat (2016)

³⁰ Earth Talk (2012)

³¹ For further discussion of organics recycling and municipal approaches to food waste management, see the Dovetail report *Organics Recycling: Addressing Food Waste and Improving Sustainability*, available at: http://www.dovetailinc.org/report_pdfs/2017/dovetailorganicrecycling0417.pdf

Livestock Feed

One of the authors of this report who operates a family farm that raises chickens, sheep, and pigs, among other things, reports that food waste is not a problem since food not eaten by his family is utilized as livestock feed. His neighbors also supplement the feed for their livestock with food scraps. Existing state and federal regulations restrict the use of food scraps as feed for animals to be used for commercial meat production. These regulations could be reviewed and updated to help further address food waste concerns.³²

Summary

Food waste is a global problem that is serious not only because so many people go to bed hungry every night, but also because of the very large environmental impacts linked to production of edible food that is discarded rather than eaten. Although food waste at the consumer level constitutes only one-fifth to one-seventh of total estimated food loss and waste based on food mass, the loss of edible food once it reaches the intended ultimate consumer has a much higher environmental impact than the percentage of mass would suggest. This is because all of the inputs required to produce, harvest, transport, process, and distribute food are embodied in edible food whether or not that food is eaten.

Individuals have the power to reduce dramatically the level of food waste that now routinely occurs at the consumer level. Changes in food habits can enhance the quality of food eaten, save money, help to solve the problem of undernourishment of a significant part of the population, and significantly reduce the environmental impacts of uneaten food.

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