An Environmental Analysis of The Food Recovery Act of 2017

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EXECUTIVE SUMMARY

Food waste has become a major global challenge, with estimates of wasted food ranging from 32% worldwide in 2009 to 40% in the U.S. in 2012. Loss of edible food occurs at all stages of the food cycle. This may result from food left unharvested in the field, inappropriate handling and storage throughout the supply chain, which causes food to spoil or spill, or from consumer purchasing and consumption habits, which often result in edible food being discarded prematurely.

Food waste results in a variety of harmful environmental consequences, including greenhouse gas emissions that contribute to climate change, and unnecessary use of valuable resources such as water, land, and energy. Addressing food waste, therefore, also addresses waste in the resources involved in food production. The Food Recovery Act of 2017 aims to minimize food waste both upstream and downstream in the food supply chain. The bill was proposed on July 27, 2017 by U.S. House Representative Chellie Pingree of Maine. It addresses the significant amount of food waste generated by different sectors of the food system: farms, retail establishments, restaurants, schools and other institutions, and consumers. The bill would implement programs, issue guidelines, and promote facilities, technologies, and funding to reduce food waste in each of these sectors.

This report details a science-focused analysis of the environmental problems of food waste and a subset of the solutions that the bill recommends. These include the installation of anaerobic digesters on farms, improvement of food storage in transportation, standardization of food date labeling, and investment in composting practices through research and regulation. The analysis also includes considerations of the limitations and controversies related to the solutions and explores methods that can be used to evaluate their success.

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INTRODUCTION

In a world of dwindling resources and increasing human population, providing food to all people is becoming more and more difficult. Under these circumstances, food waste has become a major global challenge, bearing both economic and environmental costs.

Data on the extent of food waste in the U.S. varies between studies due to inconsistency in methods. The Natural Resources Defense Council (NRDC) reports that 40% of food goes uneaten annually (Gunders & Bloom 2017). This estimate is based on a 2017 analysis of studies undertaken by the U.S. Department of Agriculture (USDA), U.S. Environmental Protection Agency (EPA), National Institutes of Health (NIH), ReFED, an environmental non-profit, and the U.N. Food and Agriculture Organization (FAO).

Food waste is responsible for substantial environmental problems. A massive quantity of solid waste is produced as a result of food that is wasted or discarded. Food waste is the single largest waste component entering municipal landfills in the U.S. (EPA 2018a), and the decomposition of this waste contributes greatly to emissions of methane and carbon, exacerbating the human impact on the greenhouse effect (Zhang et al. 2014). Carbon emissions associated with the shipment of food, along with the transit of discarded food to landfills, further increases greenhouse gas emissions. Moreover, food waste manifests itself into energy waste as well since all of the energy invested in producing, transporting and processing it, goes to waste when food is discarded. Reducing food waste will increase energy efficiency in the food system, an essential step in a world where efforts are focused on investing in new sources of energy and minimizing carbon emissions. Furthermore, food waste generates water waste, given that large quantities of water are utilized to produce, distribute, and sell food that is either rejected or discarded by farmers, retailers, or consumers.

In 1996, the U.S. Congress passed the Emerson Good Samaritan Food Donation Act, providing liability protection for food donations to those in need. By providing protection to a wide variety of donors, such as individuals, businesses, government entities and food recovery organizations, the Act supports the reallocation of uneaten food to those in need, rather than letting it rot in a landfill, while mitigating food insecurity across the U.S. Additionally, federal tax incentives promoting food donations have made them more cost effective (ReFED 2018). In 2015, the USDA and the EPA declared an unprecedented federal goal of cutting food loss and waste in half by 2030 (EPA 2016). As a consequence of this effort, the 2015 Food Recovery Summit identified opportunities and suggested actions that stakeholders could take across the food supply chain, further catalyzing prevention and recovery of discarded food.

Seeking a comprehensive and binding policy that unifies disparate policies, Congresswoman Chellie Pingree of Maine introduced the Food Recovery Act in July 2017 as a means of addressing the staggering amount of food wasted annually in the U.S., attenuating the associated environmental and economic costs of food waste, and seizing this as an opportunity to feed food insecure Americans. The bill incorporates measures to reduce waste at all stages of the food cycle. Examining how food waste manifests within specific domains, the bill is divided into five titles: farms, retail and restaurants, schools and other institutions, food date labeling and consumers, and local infrastructure. While the bill covers numerous actions, this report will focus on selected measures, illustrating programs targeted at different stages of the food cycle.

In the production stage, installing anaerobic digesters on farms will reduce unmanaged decomposition of food waste that results in greenhouse gasses that can be captured and used as a fuel source. Loans and grants, provided through the bill, will encourage food producers or rural small businesses to implement waste-to-energy facilities. In the distribution stage, the bill modifies a federal loan program to improve food storage during transportation by increasing the usage of refrigerated vehicles. In the consumption stage, the bill standardizes food date labeling by reducing the variety of phrases that can be used to denote food safety or quality. Uniform labels denoting safety and quality will be created, giving particular consideration to differentiating safety from quality, as a means of effectively communicating health risks to the consumer. Creating financial support and providing regulatory guidance for municipalities and counties to adopt composting facilities will address some of the environmental problems associated with including food wastes in the municipal solid waste stream.

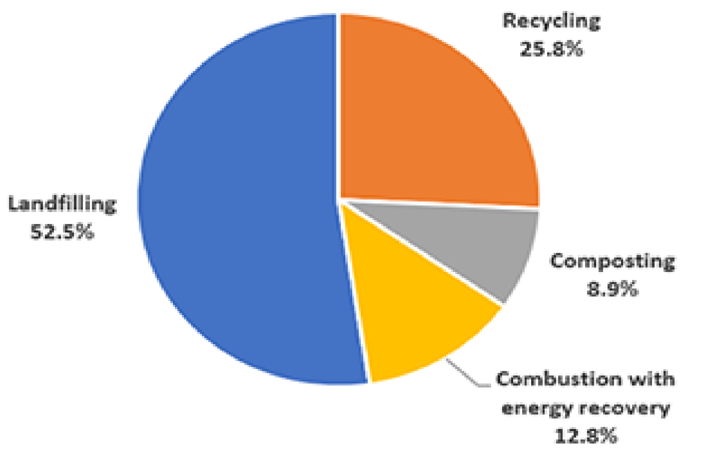
ENVIRONMENTAL PROBLEMS

The Food Recovery Act aims to reduce food waste by tackling multiple inefficiencies identified within the food system, minimizing the waste of finite resources, and reducing the transportation and accumulation of solid waste in landfills.

Solid Waste

The primary method in the U.S. for disposing of solid food waste is to send it to landfills (Figure 1). The EPA reported that food waste comprises about 15% of waste in landfills (EPA 2018a). This massive amount of solid food waste increases the nation's burden on providing landfill capacity. A lack of facilities and financial resources are challenges to the efficient collection and transportation of municipal waste (Nguyen-Trong et al. 2017). Collection and transporting food waste consumes energy and consequently contributes to climate change.

Figure 1: Municipal Solid Waste Management in the U.S. in 2015



Source: EPA 2018a

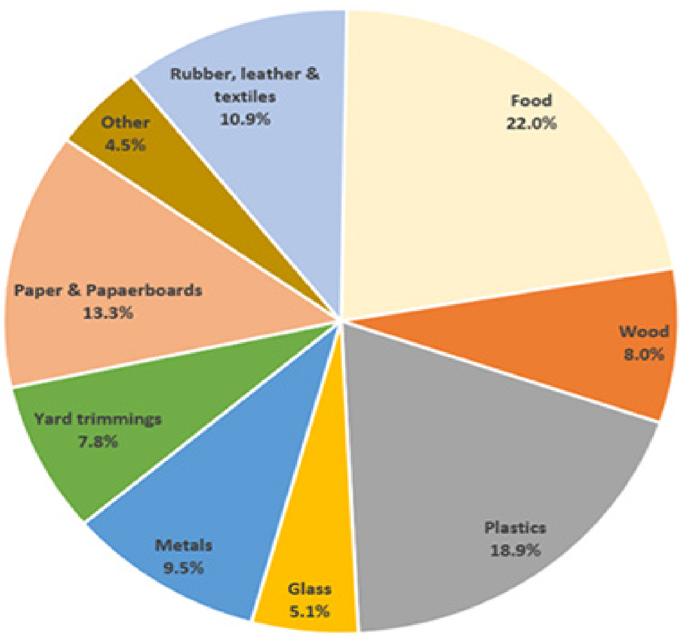
Environmental Implications

Landfills pose a risk to the environment largely due to the greenhouse gases generated by decomposition. Food wastes, which are primarily organic matter, can decompose anaerobically or aerobically. Anaerobic decomposition occurs when organic matter is not exposed to oxygen, which is the case in most landfills. Anaerobic decomposition produces methane gas in addition to carbon dioxide (Zhang et al. 2014). Aerobic decomposition occurs in the presence of oxygen and produces carbon dioxide (CO2) and water. Both gases, methane and CO2, contribute directly to climate change (IPCC 2014).

Potential threats of greenhouse gas emissions

Greenhouse gases trap heat when the vibration frequencies of their particles match the frequencies of outgoing wavelengths of longwave radiation or heat emitted by the Earth, causing the Earth's temperature to increase (Ramanathan et al. 2009). Cumulative CO2 emissions and projected global temperature increases nearly have a linear relationship. Surface temperature is also projected to rise over the 21st century based on IPCC emission scenarios (IPCC 2014). Methane is 21 times more potent as a greenhouse gas than CO2 (Houghton et al. 1996). Solid waste disposal sites such as landfills account for 14% of anthropogenic methane emissions in the U.S. (EPA 2018b). Given that food waste accounts for 22% of total waste in landfills in the US (Figure 2), the effort to divert food waste from landfills presents an opportunity to significantly reduce greenhouse gas emissions.

Figure 2. Total municipal solid waste landfilled (by material) in the U.S. in 2015



Source: EPA 2018a

Waste of resources required for food packaging

A large portion of food comes wrapped in paper and/or plastic. According to the EPA, the containers and packaging generated in 2015 amounted to 77.92 millions of tons, with 37.7% sent to landfills (EPA 2018c). Based on data provided by the Institute of Food Technologists, almost two-thirds of total packaging waste by volume is used to package food (Marsh et al. 2007). Reducing food waste would decrease package waste. Most packaging is made of plastic, which can end up in our oceans (Eriksen et al. 2014). Plastic pollution can impact aquatic wildlife through ingestion, can impact water and air quality through the leaching of chemicals from plastics, and contributes to litter when disposed of improperly (Patrick et al. 2018).

Erosion of Topsoil

Many agricultural practices have negative impacts on soil quality. When food is produced using these methods and then wasted, the costs to soil quality are incurred without any real benefit. For example, soil erosion casues the loss of key nutrients needed to sustain plant life (such as phosphorus, nitrogen, and potassium) that lie primarily within the thin, upper layer of soil known as topsoil. On average, this layer is only about 5 to 10 inches thick, but it can take at least one hundred years to create one inch of soil (ACS 2006). Nearly 33% of the world's arable land has been degraded due to erosion or pollution in the past 40 years, with topsoil being lost at a rate that far exceeds the rate of replenishment (Cameron et al. 2015). Water and wind cause erosion, though cover crops and other on-farm methods can help to prevent the erosion of topsoil (Büchi et al. 2018). However, widespread farming practices like tilling disrupt soil structure, accelerate runoff and erosion, and contribute to poor water infiltration (Al-Kaisi 2004). The impacts of food waste are compounded when considering how those soil losses reduce future yields and the sustainability of agricultural production. Reducing food waste could reduce pressure on agricultural production and allow farmers to improve their soil conservation practices.

Water Waste

Agriculture collectively uses about 70% of the global water withdrawals (Rosegrant et al. 2002). Food products require various amounts of water throughout their life cycle. Fruits, vegetables, and meat are considered to be the largest consumers of water on a weight basis because they require more water in their production than other foods. Yet, even within these food groups, the water use required for producing each item varies significantly, as shown in Figure 3.

Figure 3. Water required to produce various food products, in shower minutes.

PRODUCT	QUANTITY	WATER USE EQUIVALENT IN SHOWER MINUTES (= 10 SHOWER MINUTES)
Beer	8 oz/240 ml	4
Tomato	1 lb/455 g	5
Wine	4 oz/120 ml	6
Milk	8 oz/240 ml	6
Potato	1 lb/455 g	7
Egg	1 egg	11
Banana	1 lb/455 g	42
Apple	1 lb/455 g	43
Pasta, dry	1 lb/455 g	44
Rice, white	1 lb/455 g	60
Personal pizza	26 oz/735 g	67
Chocolate	4 oz/115 g	90
Chicken	1 lb/455 g	104
Cheese	1 lb/455 g	122
Pork	1 lb/455 g	144
Beef	1 lb/455 g	370

Estimates reflect a global average, but water use varies by geography and production methods. These numbers conservatively assume a shower uses 5gl/19L per 1 minute, which is twice that of a new shower-head sold today.

Source: NRDC 2017

In addition to water used in the production of food, water is also used in the handling and retailing of food. About 15% of total water used in commercial facilities in the U.S. is for food service, primarily in restaurants (Mayer et al. 1999).

It is estimated that by eliminating 20% of food waste, up to 1.5% of freshwater use in the U.S. could be reduced, equating to about 1.6 trillion gallons per year (ReFed 2016). Agricultural water consumption can draw heavily on both the energy and water distribution systems. Reducing food waste would improve the efficiency of water used for agricultural production, which means less energy needed for water distribution. This will ultimately result in reducing greenhouse gas emissions during energy production and reduce the impact on climate change.

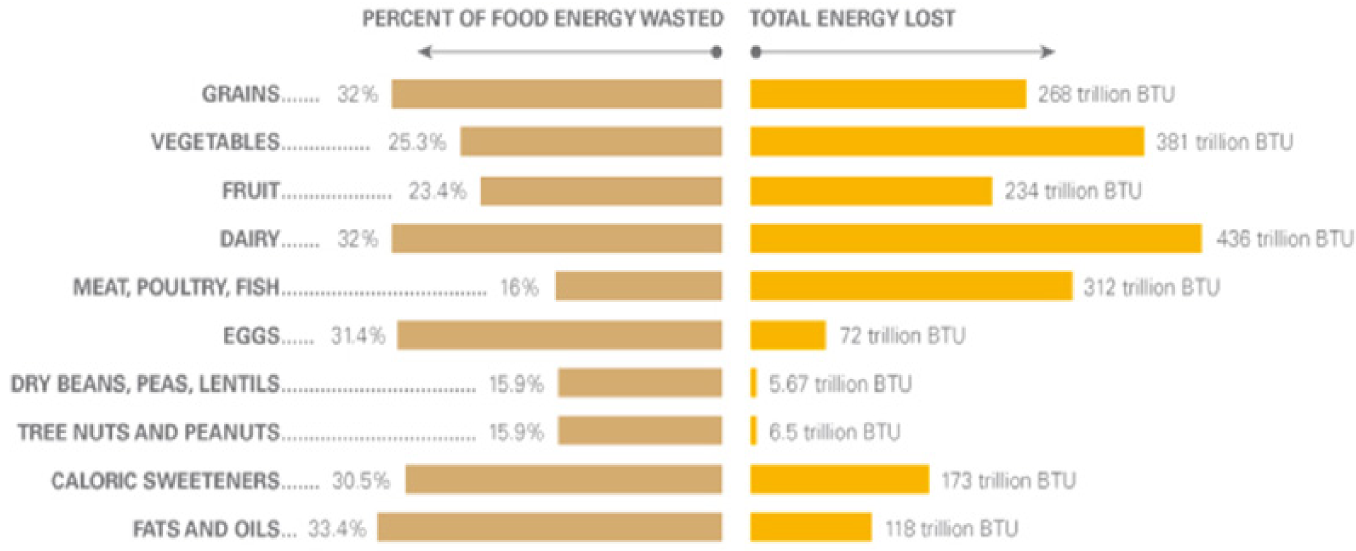
Energy Waste

About 10% of the U.S. energy budget goes to bringing food to our tables (Webber 2011). Energy is used in all stages of the food cycle. Thus, food waste is a form of energy waste. In 2007, 2030 trillion BTU's of energy were embedded in wasted food from all stages of the food cycle. Of all the energy used in food production in the U.S., approximately 25% of it goes to produce food that will be wasted (Cuéllar et al. 2010). Figure 4 shows the difference in energy waste according to food group. the In this section, the discussion will include energy waste based on food discarded in each stage of the food cycle.

Energy use in agriculture

About 13% of the above mentioned total energy invested in wasted food in 2007 was used in agriculture (Cuéllar & Webber 2010). For example, 19% of all fertilizers used in agriculture, produced with energy-intensive methods involving the use of oil and gas, is spent on food that is wasted

Figure 4. The percentage of food energy wasted and the total energy lost for each food group in trillion British thermal units (BTU)



Source: Webber 2004

(ReFed 2015). According to a report by the USDA in 2016, the U.S. agricultural sector consumes energy in several forms such as natural gas, diesel, gasoline, electricity, and the embedded energy inputs such as fertilizer and pesticides. In 2014 the agricultural sector in the U.S. consumed 1,714 trillion BTU of energy accounting for about 1.74% of total U.S. energy consumption (USDA 2016).

Energy use in transportation

Food is transported from farm to processing facility and/or distributor to retailer, to consumers' home, and finally to landfills when it is not eaten. This can involve national and international transportation via trucks, ships, and airplanes. About 1,690 trillion BTU's of energy were used moving food that would eventually be wasted through the transportation sector in 2007 (Cuéllar & Webber 2010). Transportation of food consumes petroleum products (gasoline or diesel), a non-renewable source of energy. The burning of these petroleum products emits greenhouses gases into the air, causing global temperature increase, as discussed earlier. Hence, reducing food waste will likewise help us mitigate pollution and associated risks of climate change.

Energy use at the retailer

Refrigeration is necessary for dairy products, vegetables and fruits, poultry, beef, and many processed foods. Of their total energy consumption, food retailers use about 48% of their energy just in refrigeration alone (Jamieson 2014). The portion of food wasted by retailers after incurring these energy costs represents a waste of that energy.

Consumer energy use

Consumers use energy for their food in refrigeration, cooking, and cleaning. The average U.S. home uses about 7% of its energy for refrigeration and an additional 2% for freezers (EIA 2017). Freezing food can help reduce food waste by increasing shelf life, compared to keeping food in the refrigerator where it may spoil more quickly.

Consumers also use about 4% of their energy for cooking and running electric dishwashers (EIA 2017). Some of the food we cook ends up being thrown in the trash and wasted, therefore the energy invested in cooking that food was wasted as well. Reducing food waste can mitigate the waste of energy used in cooking and cleaning. Without reliable data on consumer behavior, it is difficult to estimate the amount of energy used on food that is wasted. Due to economic growth and the declining price of food, relative food waste percentages may have actually increased between 1995 and 2018 (Cuéllar & Webber 2010).

PROPOSED SOLUTIONS

The Food Recovery Act of 2017 addresses food waste through multiple approaches and is divided into five titles: (1) farms, (2) retail and restaurants, (3) schools and other institutions, (4) food date labeling, and (5) consumers and local infrastructure. This report will focus on a subset of initiatives described in the bill, including the installation of anaerobic digesters on farms, the improvement of food storage in transportation, the standardization of food date labeling, and investment in composting practices through research, development, and regulation. Other solutions not addressed in this report include improving schools' access to local food, storage and distribution systems for emergency food assistance programs, reporting on food waste to Congress, media campaigns to educate the public about food waste, and the establishment of a Food Recovery Liaison within the Office of the Secretary of Agriculture to coordinate these measures. Recognizing systemic inefficiencies that lead to waste, the bill acts to mitigate them across all stages of the food system: production, distribution, consumption, and disposal.

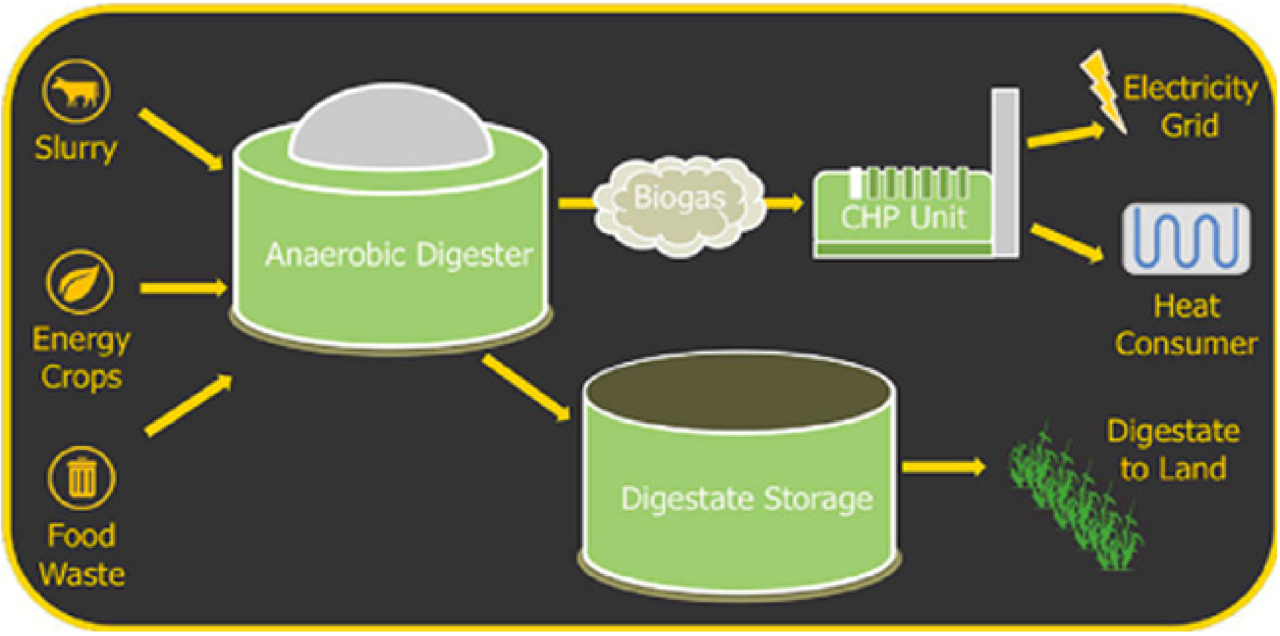
Anaerobic Digesters

Anaerobic digesters are facilities that can help manage food waste on farms and utilize that waste to produce biogas, a form of renewable energy. The bill establishes loans and grants to farmers for anaerobic digesters. Anaerobic digestion refers to the process of organic matter breaking down in the absence of oxygen into a mixture of gases, primarily methane and carbon dioxide (Zhang et al. 2014). Since both of these are potent greenhouse gases, the anaerobic decomposition of food waste becomes a significant problem, as discussed earlier in this report. However, using anaerobic digesters to divert this food waste would allow farmers to harness the biogas as energy instead. This would both reduce greenhouse gas emissions as well as power farm equipment using an alternative to fossil fuels.

Digesters take in food waste, in addition to energy crops and animal wastes, which are also organic materials that can break down into biogas (Figure 5). Bacteria catalyze the breakdown of food waste in two steps: hydrolysis and acidogenesis. The products from these reactions are first converted into hydrogen, carbon dioxide and ammonia, which are then converted into methane and carbon dioxide, the two major products of digestion. At this point, the biogas is collected and separated from the remaining solid and liquid materials known as digestate, which contains many nutrients. Digestate is treated and can be used as fertilizer, as a soil amendment, in composting, and as animal bedding on livestock farms. Methane is separated from the rest of the components of biogas to be used as an energy source either for transportation or to produce electricity and heat (EPA 2017a).

Most on-farm anaerobic digesters at present solely recycle animal waste. While this solves many sanitation and odor issues as well as provides some returned energy via biogas in livestock production facilities, co-digestion of manure with food waste significantly improves methane output by increasing the carbon to nitrogen ratio of the input feedstock (i.e., the organic waste that

Figure 5. Inputs and outputs of a food waste anaerobic digester. Animal slurry, energy crops (such as dead leaves and twigs) and food waste are put into the digester.



Digestion takes place, and the digester then separates biogas, which can provide energy for electricity and heat, from solid digestate, which can be used to fertilize farmland.

Source: ISL Waste Management

goes into the digester). Some digesters that are already established may be able to incorporate food waste as another feedstock, but farmers must determine if their digesters are capable of handling the increased amount of biogas that will result (AgSTAR 2012).

Challenges with the Implementation of Anaerobic Digesters on Farms

The EPA reports that there are currently 253 livestock anaerobic digesters in use on farms around the U.S. (EPA 2018a). However, as of 2015, there are approximately only 18 on-farm digesters that accept food waste nationwide (Pennington 2018). Anaerobic digestion systems can cost hundreds of thousands of dollars between installation, start-up, and maintenance (Moser et al. 1998). These costs are prohibitive to many farms, which hinders the widespread use of digesters. Additionally, farmers that currently operate anaerobic digesters on their farms have reported several other difficulties including winter operation, feedstock preprocessing, research into digester use, training in digester management, spreading awareness of the benefits of digesters, and having patience in seeing the benefits that result from the digesters [add citation here]. Notably, farmers that have put in the time and resources necessary for the utilization of digesters all agree that these are minor obstacles that are worth the trouble (EPA 2018b). Farms that already implement livestock anaerobic digesters would need to consider the various challenges of adding food waste as a feedstock. For example, some crops contain lignin, which is difficult to break down and would affect the performance of digesters. In addition, as previously mentioned, different food wastes and crops have different potential methane outputs and a digester must be equipped to deal with different amounts of produced biogas. (AgSTAR 2012).

CASE STUDY: Pilot Study in Oakland, California to Determine Feasibility of Large-Scale Food Waste Anaerobic Digester Usage

The EPA provided a grant to the East Bay Municipal Utility District (EBMUD) in Oakland, CA in 2006 to determine the feasibility of implementing a co-digestion anaerobic digester at a wastewater treatment facility. These facilities have historically utilized anaerobic digesters, but a 2006 study inwdicated that excess space in these machines could accommodate food waste (EPA 2006). The EPA carried out this study to investigate the potential benefits of diverting post-consumer food waste to these anaerobic digesters.

The results were impressive. The co-digestion of food waste with animal waste increased methane production around three- to three and a half-fold and the digestion of just 500 tons of food per week provides enough energy to power somewhere between 800 and 1,400 homes per year (EPA 2006).

Figure 6. A turbine generator at a East Bay Municipal Utility District wastewater treatment plant, driven by biogas to generate

Source: Treatment Plant Operator Magazine

The Food Recovery Act of 2017 recommends funding for anaerobic digesters not only on farms, but in communities as well as part of water and waste disposal programs. Incorporating gesters on farms can help farmers manage their own unharvested food waste, but incorporating digesters in facilities that can receive post-consumer waste clearly has wthe potential to also divert food waste from landfills and create large amounts of renewable energy.

Measuring the Success

Measuring the effectiveness of an anaerobic digester program can be achieved by comparing the amount of food waste diverted from other sources both before and after the addition of digesters. Food waste on farms will be difficult to measure because unharvested food is often just left to rot rather than being sent to landfills. Therefore, estimates of how much food is not harvested would be needed to determine how much of this waste is being diverted to the digesters. The incentive of producing valuable biogas, might push farmers to divert wasted crops to digesters.

The amount of food waste on farms diverted to anaerobic digesters can be measured by reports of farmers before and after the implementation of digesters. There is no consensus on an objective approach to directly measure the amount of marketable or edible produce that is left in the field (Hall et al. 2009). Self reports from each individual farm may be biased. One method suggested by the Center for Environmental Farming Systems is to extrapolate the amount of unused produce from a sample of crop in the field, usually measured by weight (Parfitt et al. 2010). Obvious limitations in the reliability of data like this result from the extrapolation of a small sample size.

Improving Food Storage During Transportation

Approximately 13% of food waste in the U.S. occurs during distribution, with much of this waste resulting from improper storage temperature (Gunders & Bloom 2017). Lack of refrigerated vehicles to store perishable foods contributes to waste before it is even distributed to retailers. This issue is more prevalent on small scale-farms that cannot afford to invest in refrigeration. Food transported by land in the U.S., on average, travels around 2,000 kilometers from farm to retailer (Abad et al. 2009). Therefore, it is vital to transport it at a temperature that will delay spoilage for as long as possible.

The bill addresses this problem by modifying a farm storage facility loan program to provide for refrigerated vehicles. Funds will also be allocated for improved storage facilities used under the Emergency Food Assistance Act.

Low temperatures reduce the rate of both chemical and microbial spoilage of food, thereby extending its shelf life. Chemical spoilage is caused by chemical reactions, such as the oxidation of lipids and pigments in fatty foods. While chemical spoilage rarely produces toxins that cause illness in humans, it still increases food waste because consumers mistakenly associate a decline in freshness with a safety risk (Huis in't Veld 1996). Microbial spoilage, on the other hand, can cause both mild and serious illnesses. Bacteria such as Listeria grow rapidly above 40º F (Kreyenschmidt & Ibald 2012). Therefore, refrigerated vehicles can effectively increase the shelf life of food, ultimately reducing food waste by reducing both chemical and microbial spoilage (Steele et al. 2004).

To determine the impact of refrigerated vehicles on mitigating food waste, compare the rates of spoilage for foods that are transported in unrefrigerated versus refrigerated vehicles. This can be recorded at the point of exchange from truck to retailer. With these data, it would be possible to also determine the amount of energy, water, and other food production inputs that have been saved. However, this would be difficult to accomplish without a coordinated data inventory system.

To fully assess the effectiveness of refrigerated vehicles, their increased energy consumption must also be considered. The amount of energy consumed by refrigerating vehicles should be compared with the energy saved in the food production process by their ability to delay food spoilage. It is estimated that if refrigerated vehicles were widely implemented in the U.S., approximately 12% of food waste caused by spoilage during the transportation could be reduced. This equates to around 5% of total U.S. food production (Gunders 2012). Accounting for all resources put into food production, the use of refrigerated vehicles could result in a net gain in energy efficiency (Mercier et al. 2017).

Food Labeling Standardization

Misunderstanding food labels is a major contributor to food waste at both the consumer and retail level. With the exception of infant formula, no federal laws in the U.S. currently standardize the labelling of food products (USDA 2016). The metrics for how labels are determined vary from state to state and from food product to food product (USDA 2016). Confusion over the meaning of varying food date labels, such as 'sell by' or 'use by', arises because consumers struggle with understanding whether the label denotes food safety or food quality. One study found that 42% of consumers correctly thought 'use by' was an indication of food safety whereas 40% mistakenly thought it was an indication of quality (WRAP 2017).

The Food Recovery Act of 2017 proposes to reduce food waste at the consumer and retail level by creating a federal standard for food labels. The act clarifies the difference between a safety date and a quality date with the former indicating a risk to health and the latter indicating simply a point of reduction in freshness. A safety date is defined as a date signifying the end of the estimated safe shelf life period under stated storage conditions, after which the product may pose a health safety risk. A quality date is intended to communicate to consumers the date after which the quality of the product may begin to deteriorate although it remains safe to eat.

Challenges with the Implementation of Standardized Date Labels

The Act would implement uniform safety date labels across the country with the phrase, 'use by', and allow for an additional quality date label with the uniform phrase of 'best if used by' (Figure 7). There is some controversy over the option to include an additional quality date since it does not directly play a role in maintaining public health. Manufacturers and retailers can increase profits in the absence of label standardization since consumers will purchase a product more often if it is disposed of by the quality date (Leib et al. 2013). In addition to increasing profitability, manufacturers also select more conservative quality dates since they are potentially liable if a consumer suffers from negative health consequences. Conservative date labelling may reduce the risk of foodborne illness, but it also increases food waste (FDA 2013).

Figure 7. Food labels descriptions.

Misunderstanding of these labels is a major contributor to food waste

Source: Food Safety Training and Certification

Standardizing the wording on food labels could reduce consumer confusion and ultimately reduce food waste, but unless consumers are educated about the differences between food safety and food quality labels, consumers could continue to generate food waste by treating both dates similarly. In a study in the United Kingdom, 30% of consumers believed that 'best if used by' indicated food safety rather than food quality (WRAP 2017), demonstrating that there still may be confusion regarding the new dates proposed by the bill.

Measuring the Success

Two provisions in the Act support initiatives to educate the general public about food waste, bringing awareness to the issue of food waste as well as to its proposed solutions. The first aims to promote agricultural education that encourages food recovery initiatives to reduce the quantity of wasted food on either a national or regional scale. The second provision supports national media campaigns aimed at decreasing food waste. The "Love Food Hate Waste" campaign in the United Kingdom has had a great deal of success in increasing awareness of the environmental and socio-economic impact of food waste (WRAP 2018). Through social media platforms, the campaign provides tips and facts about food waste; the campaign has also launched an app that can help users plan meals and track food that is already in their kitchen. (WRAP 2018). This is one example of a successful awareness campaign that could be replicated in the United States and ultimately contribute to the reduction of food waste.

Surveys are the most common tool used to measure data regarding consumer behavior. Measuring the success of date labeling standardization can be achieved through a survey designed to measure consumers' knowledge about food labels. Questions could include "Do you know the difference between the two dates?" and "How do you deal with food past its Best if Used By date?". The survey will not aim to quantify the amount of food actually wasted, but rather ask qualitative questions that are more effective in producing accurate answers (Neff et al. 2015). If surveys were to show that consumers' confusion regarding food labels reduced after the enactment of the bill, then the program will have served its purpose of decreasing the amount of safe to eat food being thrown away. It is important to note that consumer education regarding the difference between quality and safety dates plays a key role in executing label standardization and ensuring its effectiveness. However, surveys can be misleading in quantifying the amount of food actually being wasted. People tend to report inaccurate answers, consciously or unconsciously, in particular when asked about a behavior they perceive as negative (Neff et al. 2015). So, measuring how successful date labeling standardization is in reducing food wasted by consumers is a challenging task. A "waste audit" may be a potential solution to measure food labeling success. Through documenting the types and quantifying the amounts of unconsumed food in a small-scale analysis, one can estimate the overall food waste by consumers in the U.S. A small-scale waste audit can improve accuracy since it collects empirical data rather than relying on self-reported or estimated measures.

Composting

Composting refers to the aerobic digestion organic materials including food waste in order to produce a material known as compost. Food waste, which is high in nutrients, must be broken down along with low-nutrient wastes such as dead leaves (EPA 2017b). Composting may be performed by individuals in their own homes or gardens, or it may be carried out at larger scales at farms, industrial facilities, and cities and other municipalities (Risse & Faucette 2017).

There are a variety of benefits to composting. Food waste generally ends up in landfills which contributes to methane emissions, as described earlier in this report. However, when food waste is composted, it decomposes in an aerobic environment where methane is not produced. Additionally, the nutrients in compost can be used to fertilize soil, reducing the need for chemical fertilizers, pesticides and promoting a variety of other beneficial soil properties (Risse & Faucette 2017).

Challenges with the Implementation of Composting

Though composting has many benefits and is a better alternative to sending food waste to landfills, only about 5.3% of food waste was composted in 2015 (EPA 2018a). Municipal composting has proven particularly dif-

- *New composting facilities require space and resources. Up-front costs (planning, technology, and development of composting facilities), capital costs (land and materials for constructing and maintaining facilities) and operating costs (fuel and electricity), for composting facilities can be a substantial expense (Platt et al. 2014);*

- *Difficulty of regulating the content of composting materials collected from the public. For example, contaminants such as glass and plastics interfere with the composting process, while herbicides inadvertently introduced into facilities can contaminate compost (Platt et al. 2014);*

- *Nitrogen and phosphorus from composting facilities can contaminate nearby surface waters and groundwater (Platt et al. 2014);*

- *Residents may object to unpleasant consequences of having food waste stored at composting sites, such as odors and attraction of animals (Royte 2017);*

- *Composting indirectly contributes to greenhouse gas emissions through increases in fuel use from any additional transportation needed to manage separate compost waste streams.*

In a hypothetical scenario, if half of food waste went to composting and half to landfills, methane emissions would decrease because composting produces significantly less methane. However, it would cost more to process food waste than what a municipal waste management system is currently paying. The exact balance between the costs and benefits of composting systems will depend on the scale of the operations, the costs to manage those operations, and the relative costs of maintaining the current landfill-dependent system.

CASE STUDY: *San Francisco's Composting Efforts as part of their Zero Waste Program*

In 1989, California passed the California Integrated Waste Management Act (AB 939), which required all cities and counties in the state to implement programs with a goal of diverting 25 percent of their solid waste by 1995 and 50 percent by 2000 (CalRecycle 2015). With a vision to go beyond the state's mandate, the city of San Francisco passed their own zero-waste resolution in 2002, setting a target for 75% waste diversion by 2010 and zero waste by 2020 (EPA 2013). A robust zero-waste program must integrate composting efforts to divert food waste from landfills (Figure 8).

Figure 8. Designated waste bins, including for composting, in San Francisco. The city aims to reach zero waste

Source: San Francisco Environment, n.d.

San Francisco has partnered with Recology, a waste collection and processing organization, to execute their composting program. The city passed a mandatory recycling and composting ordinance in 2009 requiring city residents to separate recyclable materials, compostable materials, and trash to be sent to a landfill (EPA 2013). The city's program has seen great success, diverting approximately 80% of all their waste since 2012 (SF Environment 2016). Commercial composting rates for organic wastes have reached an estimated annual 49.5% (TCM 2016). A city as large as San Francisco achieving such a high food waste diversion rate sets an example for the rest of the country, demonstrating that composting at such a large scale is indeed possible.

CONCLUSION

The Food Recovery Act of 2017 aims to mitigate food waste and minimize the amount of food disposed into landfills. When accounting for each phase in the food production - consumption - disposal cycle, it is estimated that approximately 40% of food in the U.S. ends up wasted (Gunders & Bloom 2017). The scale of our food waste problem considerably exacerbates climate change. Moreover, food waste contributes to a significant waste of water and energy.

The act would support the production of biogas from the treatment of food waste through anaerobic digesters as an approach to prevent food from becoming waste in a landfill and transforming it into a source of renewable energy. Similarly, composting food waste reduces methane emissions and can be used to reduce reliance on chemical fertilizers and pesticides. Reduction of food waste during the transportation cycle can also be achieved by scaling up the use of refrigerated vehicles which extends the shelf life of perishable foods. Standardizing food date labels will help reduce food wasted by consumers and retailers and correct errors in interpreting food date labels with respect to food safety and food quality.

Providing funding for composting facilities and anaerobic digesters, upgrading to refrigerated vehicles for transportation, and standardizing food date labels, are only several solutions established in the broader bill - all aiming to reduce the amount of food being wasted and sent to landfills. As a result, the implementation of this act will scale down food waste and associated problems with energy waste, water waste, and the challenges of solid waste management.

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