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Tackling the issue of food waste in restaurants: Options for measurement method, reduction and behavioral change

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ABSTRACT

Reducing food waste has many positive environmental and socio-economic ramifications. Even though many programs exist to reduce the amount of food waste, the attitudes and the behaviors driving food waste as well as the strategies to reduce it remain poorly understood. In this paper, we investigate how restaurateurs in Berkeley, California, USA perceive food waste given current financial incentives and policies. We found that 65% of the restaurants are measuring amounts of food waste and more than three-quarters of them (84%) use compost bins to dispose inedible food waste. Our survey results also show that the most common method employed to dispose of food waste (72%) was giving edible left-overs to restaurant's employees. However, three-quarters of restaurants avoided food donation because of unfounded fear of the legal liability. Finally, 14% of surveyed restaurants dumped their food waste into landfill bins. We suggest that further studies explore ways to target specific attitudes and behavioral changes, but also to quantify the impact of these changes.

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1. Introduction

Humanity faces a grand challenge in the 21st century in determining how to best feed the world's population on a warmer and more crowded planet. Increasing food production is one possible solution. However, increasing competition for the use of land, water, and energy, in combination with increased consumption of animal products, may limit how much more food can be produced (Godfray et al., 2010). In addition, actions taken to meet increasing food demand must account for ongoing climate change (Kosseva and Webb, 2013). Another promising solution is to reduce the amount of food wasted.

Globally, the amount of food waste is estimated to be about 1.3 billion metric tons per year (FAO, 2011). The environmental impacts of food waste are substantial (FAO, 2013a). In 2013, the Food and Agriculture Organization of the United Nations determined that the amount of greenhouse gas emitted annually due to food waste in landfills is almost equivalent to the total emissions of Cuba (about 3.3 billion tons of CO2e/yr) and that food waste accounts for the annual global loss of water of about 250 Km^3 which is equivalent to three times the volume of Lake Geneva in Switzerland (FAO, 2013a; Papargyropoulou et al., 2014).

Beyond the environmental benefits, addressing food waste helps to tackle issues regarding food availability and self-sufficiency, particularly in developing countries (Scialabba, 2011). In developing countries, the reduction of quantitative losses (losses of fresh fruits and vegetables which are due to product spoilage) is of higher priority than addressing the qualitative losses (such as consumer preference) (Kader, 2005). The opposite is true in developed countries, where consumer dissatisfaction with produce quality results in a greater percentage of the total post-harvest losses (Kader, 2005). Thus, developed countries tend to have more food waste than developing countries. For example, in North America and Europe, the amount of food wasted by consumers is 209–254 pounds per year, while in Sub-Saharan Africa and South/Southeast Asia it is 13–24 pounds per year (Buzby et al., 2014).

Moreover, in the United States (US) alone, it is estimated that 40% of edible food is not consumed, leading to about 37 million metric tons of food being wasted per year (Gunders, 2015; Hall et al., 2009). According to the Food Waste Reduction Alliance (FWRA), about 37% of food waste occurs in retail stores and food services (FWRA, 2014). Dining places like cafeterias of educational institutions, hospitality, and private companies which offer buffet style foods (especially with an all-you-can-eat system) are

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particularly wasteful (Gunders, 2012). The restaurant service sector typically wastes 4–10% of purchased food before it reaches the customer in the United States (Baldwin et al., 2011). A US Department of Agriculture (USDA) study in 2014 showed that 21% of food available in restaurants was not being eaten (Buzby et al., 2014). From a financial perspective, anywhere between 9 and 23 billion USD worth of food is wasted annually (LeanPath, 2016). However, if a foodservice business is tracking the food waste generated, this can often catalyze up to a 7% reduction of food waste as compared to businesses that do not track food waste (LeanPath, 2016). If widely implemented, this could save $1.3 billion each year for food businesses (ReFED, 2016).

However, according to Waste and Resources Action Programme (WRAP), restaurant service operators do not believe that food waste lies in their area of responsibility, and as a result are not incentivized to operate differently and move towards more sustainable practices (WRAP, 2013). The most common causes of wasted food in the restaurant service sector include: incorrect storage, preparation residues such as improper handling of food products and over-preparation, excessive portions and leftovers on plates, difficulty in forecasting number of clients, forgotten and spoiled food, lack of awareness due to poor food waste data and its economic and environmental costs, and lastly, difficulty in meeting dietary preferences of clients (Ofei and Mikkelsen, 2011).

Given these financial and environmental impacts especially in industrialized countries with the capacity to implement economic policies and environmental incentives, the amount of food being wasted remains a challenge. In this paper, we explore what factors influence behaviors and attitudes among restaurateurs regarding the policies and incentives to reduce food waste. Specifically, we report the results of a survey of food service providers in Berkeley, California, USA and discuss the relationship between restaurants and their food waste prevention practices.

The survey explored the "food waste landscape" by assessing the (i) types of restaurants, (ii) the current food waste prevention practices at restaurants, and (iii) how restaurants consider food donation and liability. Our results suggest that there are knowledge gaps rather than inefficacious policies or financial incentives, and that social and economic objectives of a restaurant can help understand the attitudes and behaviors towards food waste.

2. Background and possible solutions

Food waste research is an emerging subdiscipline of waste research. It is motivated by environmental concerns which include climate change, loss of biodiversity, pollution of air and water, fossil fuel consumption, overharvesting, and many others (FAO, 2013a). The complexity of the problem arises from the diverse food production economy, which has a multitude of interactions among suppliers, consumers, managers, and waste management operators. However, collaboration among different stakeholders is not yet sufficient and more effort is needed to decrease the impacts of food waste (Lipinski et al., 2013).

2.1. Incentives and the low hanging fruit

Wasted food may be described as a low hanging fruit, since the ways of making positive impact on the reduction of food waste are applicable to a majority of the global population, especially in industrialized countries where a surplus of food is available (Strickland, 2016). The incentives and ways of behaving more environmentally friendly are quite simple to implement in a home setting and involve behavioral changes that can be adopted quickly and lead to direct and positive impact. Some of the more environmentally friendly behaviors suggested by the United States Environmental Protection Agency to reduce the food waste (EPA, 2016a) include storing bananas, apples, and tomatoes by themselves, storing fruits and vegetables in different bins, freezing any food that one cannot eat in time, and understanding expiration dates (EPA, 2016a).

While encouraging environmentally friendly behavior is imperative for reducing food waste, tax incentives and policies can facilitate sustainable behaviors. In the beginning of 2016, the US Congress signed a provision, the Protecting Americans from Tax Hikes (PATH) Act, that enables food businesses to receive tax benefits when donating food to charitable organizations. Before the PATH Act, it was only possible for larger corporations to obtain tax benefits. With this legislation, it is now possible for businesses to claim potential profits for the inventory, if sold at a fair market value (ReFED, 2016).

2.2. Awareness of food waste

Awareness about food waste has been rising in recent years, which is reflected in data from online search engines. The Google web search trend analytics show a steady increase for the term "food waste" from 2004 to 2016 (Google, 2016). It shows a peak in search for food waste during the 2015 Conference of the Parties held by the United Nations (UN) general assembly in Paris during which the Sustainable Development Goals (SDG) on food waste were introduced. Target 3 of the 12th SDG for sustainable consumption and production, introduced by the UN in 2015, has a similar objective to the USDA goal: to cut the amount of food waste per capita by 50% on the retail and consumer levels by the year 2030 and to reduce food losses occurring along the entire supply-chain and more specifically during production and post-harvesting (United Nations, 2015).

On the national level in the US, the first legislation directed at food waste reduction was introduced at the end of 2015, mainly due to the effort of House of Representatives Congresswoman, Chellie Pingree. It aimed to reduce food waste in the framework of the Food Recovery Act (Pingree, 2015). The bill included several provisions, directed at reducing food waste at the federal level (Pingree, 2015). Due to these regulatory changes, federal governments including Congress and the military will need to establish new partnerships with charity and faith-based organizations and stakeholders in the private sector in order to provide a sustainable basis for reducing food waste (USDA, 2015). Incentives, linked to the regulatory legal provisions by the US government, are expected to impact overall economy-wide food waste reduction and add momentum among policy makers and stakeholders across industries to address food waste (EPA, 2016b).

2.3. Possible solutions to address food waste

2.3.1. Efficiency

Implementing a detailed system, such as a weight-based system, to quantify the amounts of food waste has been shown to be highly effective in reducing food waste especially for catering businesses (Shakman et al., 2008; NRA, 2016). However, the current tools for assessing food waste are highly complex or lack accuracy. Weight-based systems are highly accurate, but necessitate laborious effort and space for dining facilities (Hanks et al., 2014). In contrast, visual analysis of waste made at regular intervals are easy to implement but can only determine patterns of leftover food or overbought foods (Hanks et al., 2014). Overall, food waste tracking is not widely done by foodservice operators. Foodservice operators often do not believe they have the time to add such tracking tools to their business operations (FAO, 2013b).

2.3.2. Donating food

Among restaurants, potential liability from donating food is a common misconception. Retailers are deterred because of the fear of lawsuits, such as, donated food causing health problems for consumers. The act of donating food has been legally regulated since 1996 by the US Congress in the Bill Emerson Good Samaritan Act, which protects restaurants from liability after food has been donated. In California, the California Civil Code Section 1714.25(a) states that no food facility that donates any food for human consumption to nonprofit charitable organization or food bank is liable for any damage or injury resulting from consuming donated food (State of California, 1996). Moreover, no legal consequences, such as lawsuits, have been reported concerning donated food since 2013 (University of Arkansas, 2013).

Beyond misconception of potential liability, one of the most significant hurdles for restaurants is the actual logistics of donating food. Prepared food that has not been served to customers can be considered for donation. However, the transportation and storage infrastructure requirements are high for the successful donation of prepared food, and restaurants tend to have less storage space available than retail grocery stores or manufacturing facilities (FWRA, 2016). In a survey by the Food Waste Reduction Alliance, 43% of respondents surveyed in FWRA identified transportation constraints and 39% indicated insufficient refrigeration and/or onsite storage as challenges (FWRA, 2016).

2.3.3. Education and knowledge exchange

In the interconnected and dependent world of today, coordinated decision making is needed, since local actions can have global impacts (Dodds and Bartram, 2016). Single communities or businesses often do not foresee or make decisions based on the potential impact on others or at a larger scale. Education and improved exchange can thus help create a collaborative effort to tackle food waste across the whole food supply chain, including consumers (Evans and Welch, 2015).

Specific actions that could be taken include: more international collaboration, coordinated waste prevention initiatives on national and regional levels by governments and/or the private sector, enhancement of communication between different stakeholders, and more integration of food waste prevention efforts with other strategies for sustainable behavior (USDA, 2015).

3. Materials & methods (case-study)

We conducted our work in Berkeley, California, USA. Berkeley is located in the San Francisco Bay Area and has a population of about 112,000 people (US Census Bureau, 2010). Berkeley is well known for being progressive and is seen as a leader in climate action. Berkeley ranked one of the top nine in the USA for tracking greenhouse gas inventories (measured by conducting an inventory of emissions by source) among cities of 100,000 plus population. It is also third in the nation in the percent of residents who walk to work (18.1%), and fourth in the nation as a solar-energy production for medium sized cities (Burroughs et al., 2015). With respect to food waste, the City of Berkeley provides information for businesses in the forms of online information campaigns, as well as interactive webinars on how to measure food waste effectively and how to develop estimates of the amount of food waste generated (City of Berkeley, 2016).

To determine restaurant attitudes toward food waste, an electronic survey was developed. The survey was created with the Google web app, "Forms," and consisted mainly of multiple-choice questions with a few fill-in-the-blank questions (Table 1). The questions were focused on the business as a unit, so no personal information was collected. Questions were structured to ask about the management of the restaurant (basic company information and offered products), knowledge about food waste (waste management), and the actions, if any, taken to reduce food waste (food

Fig. 1. Guide for how restaurants can reduce food waste.

reuse, donation, customer and staff incentives). In our survey, the definition of food waste applied only to the food that had already left the kitchen. At the end of the survey, restaurants could indicate if they desired "further consulting". For those restaurateurs who were interested in, our research team provided 30 minutes of consultation in order to verify the inputted data in the survey and to obtain more background information for the research. More information through an infograph (Figs. 1 and 2) on how to prevent food waste was presented to the survey respondents at these meetings.

The restaurants were chosen with the help of the online restaurant search-engine Yelp (https://www.yelp.com) and were selected at random without consideration for ratings or reviews. Only pricing level and location in Berkeley were considered. Survey invitations were sent to selected restaurants by email or via web forms on their websites. The survey and follow up consultations took place between February 2016 and March 2016. Excel Spreadsheets were used to analyze the survey data. Extra space was given for elaborated responses and used for building discussions about the barriers of reducing food waste in restaurants.

Out of the 133 restaurants contacted, 15% of the restaurants responded promptly or after receiving 1–2 reminders about the survey. Information from another 9 restaurants was collected by asking the survey questions in-person. Overall, the response rate was 22% (29 restaurants). The on-site visits provided corroborative evidence that the online survey questions were valid and reliable. During the consultation, the main reasons cited for lack of participation in the survey were hesitation of providing data which would be labeled as "bad practice" examples as well as limited time to provide answers for the survey.

Sixty six percent of restaurants surveyed had about 10–50 seats and 49% had between 7 and 15 employees. In terms of types of food and menus, 62% of the restaurants made food from scratch and 86% offered a fixed menu or one that only changed slightly. In terms of ownership, 24% were chain restaurants and the remaining 76% were independently owned. See Table 1 for the survey questions and Table 2 for a breakdown of the restaurant responses to the questions.

The survey was conducted based on convenience of the sample restaurant locations in Berkeley and should not be considered a representative of the overall restaurant sector of the US. However, it can be used as a case study to explain the attitudes and behavior of restaurants in Berkeley, CA and to develop better food waste prevention programs.

3.1. Information beyond the survey (consultation process)

The discussions during the consultations, which followed the survey questions, provided an additional way to gauge the extent of knowledge around food waste. In many instances, food waste reduction strategies and management practices had to be introduced and explained to the restaurant managers. General knowledge about food waste and the legal framework regarding donations were also popular topics of discussions. During these discussions, about 50% of the managers who asked for consultations showed high interest in sustainable behavior and mentioned that their personal interest in protecting the environment is what led them to establish food businesses that offer sustainably sourced ingredients. Although these considerations are usually not visible to customers, such practices seemed to be appreciated by the customers when they were presented, according to the business operators.

Topics that were not directly related to the survey questions came up during the consultations, especially with regards to local policies and laws related to food waste as well as restaurant-specific problems. Many of the managers requested further information on how to learn more about food waste, as well as updates on the ongoing research so that they can better understand their food waste behaviors compared to other Berkeley restaurants.

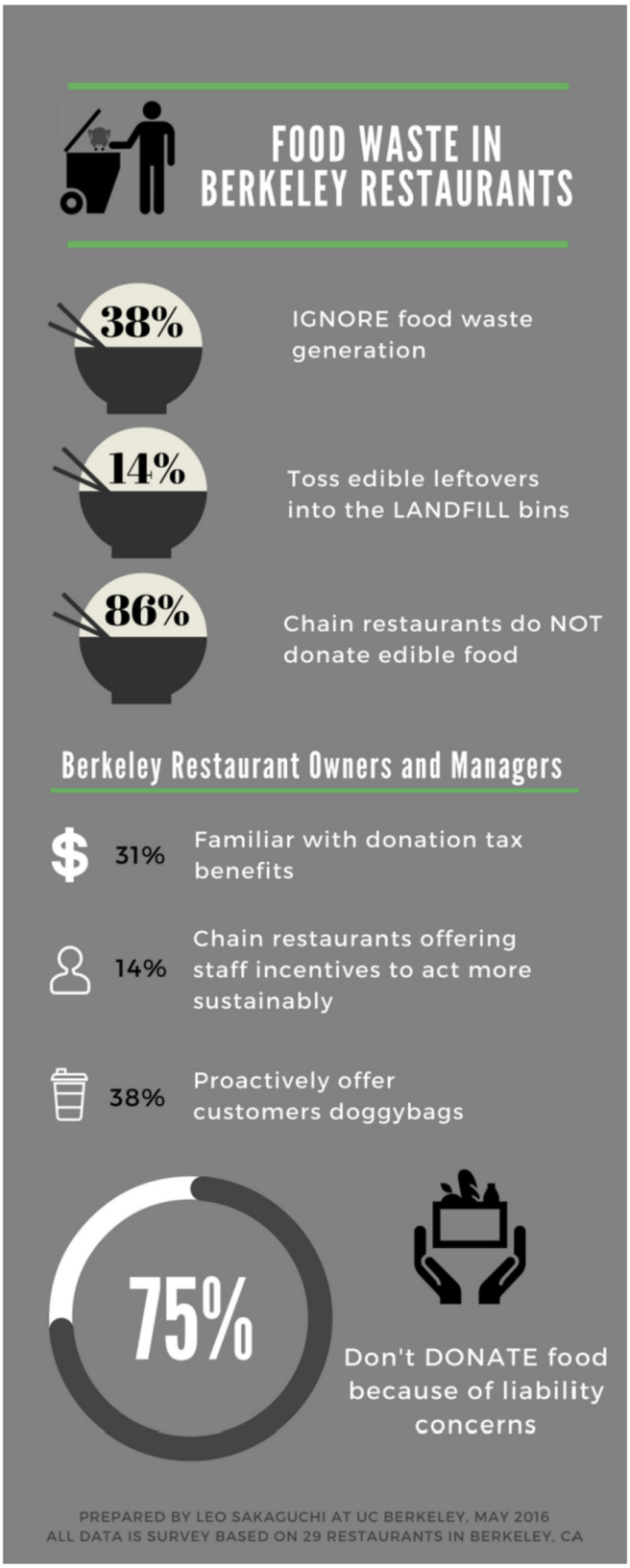

Fig. 2. Summary of restaurant survey results.

4. Results

4.1. Food waste accounting methods employed

The results of the survey show that 34% of restaurateurs did not measure the amount of food waste they produced. Based on our consultation, they did not seem to perceive wasted food in their dining businesses as a big problem.

About a quarter of the surveyed businesses (24%) used manual food waste accounting tools based on purchase and inventory sheets. In this method, a restaurant quantifies the amount of food purchased as well as the amount of leftovers thrown away. By keeping track of what comes into the kitchen and what is disposed, a restaurant can estimate the amount that is regularly wasted and can identify patterns of food wasted.

A weight accounting method was used by only a few businesses (about 7% of restaurants). This is done by using a software system that keeps track of the exact weight, in addition to the types of food wasted and the reason for disposal (inedible, edible, spoiled, leftovers, pre- or post-consumer). The restaurants that used weight accounting were mainly chain-restaurants.

4.2. Disposal of food waste

In Berkeley, business owners are incentivized to compost rather than to dispose in landfills. Since July of 2015, the hauling cost for compost bins has been 20% less than the price for hauling landfill bins. According to the City of Berkeley, regular checks are conducted on the landfill bins to determine the amounts of compost in the landfill bins. The City of Berkeley has no description of how these checks are conducted and they have yet to identify bad practices (City of Berkeley, 2016).

The survey results show that the most common method employed to dispose of food waste (72%) was giving edible leftovers to restaurants employees. Based on our consultation, it was not always clear to the employees as to the exact amounts and types of food they could take home. In many restaurants, it was an unspoken rule.

Proactively asking restaurant customers to take home leftover food in doggy bags (38%) was the next most common method of waste prevention. Common reasons given for low utilization of this method based on our consultation were lack of time, the cost of to-go packaging, insufficient training of the staff, and food safety concerns. Moreover, 14% of the surveyed restaurants dispose left over food into landfills. None of the surveyed restaurants had a compost compactor (in-vessel) composting system.

4.3. Awareness of disposal options

During the consultation about food donations, the surveyed restaurant managers mentioned concerns about food donations due to potential liability. According to our survey, 75% of the restaurants indicated that liability uncertainties kept them from donating excess food. After explaining the protection granted by the Bill Emerson Good Samaritan Food Donation Act, over half of the consulted restaurants approached this issue more positively and said that they would consider food donations and asked for more details on this specific law.

4.4. Collaboration with charity organizations and tax benefits

79% of the surveyed restaurants did not have any collaboration with charities to donate surplus food (churches, Food Not Bombs, etc.). During our consultation, the limited time frame that is given by charity organizations for pickups was mentioned multiple times as a determining factor, especially since restaurants have leftovers in late evenings and usually do not encounter many willing volunteers at these times.

When asked about the extent of their knowledge on tax benefits, 69% restaurateurs answered that they were not eligible for the benefit or did not know the details about it. The tax benefit law, which is known as Protecting Americans from Tax Hikes (PATH) act, was not known to most of the restaurateurs. However, the restauranteurs may have known about the general (non-enhanced) tax deduction, a tax benefit law before PATH that only applied to large businesses such as C-corporations (ReFED, 2016).

5. Discussion

5.1. The gaps of knowledge

The fact that 14% of the surveyed restaurants in Berkeley are disposing their inedible food waste into landfills seems to match with our high expectations of Berkeley restaurants given the various city governmental incentives for compositing. However, during our consultations, some restaurateurs that admitted to disposing food waste into compost bins were in fact also disposing in landfill bins, explaining that they did not have the time and resources to change their behaviors. Although there are programs in the vicinity like The StopWaste Initiative, a public agency that connects and supports companies and institutions to help lower cost, none of the consulted restaurants knew about it (StopWaste, 2016). This lack of knowledge could be ameliorated by increasing contact between stakeholders (like the City of Berkeley and neighboring businesses), restaurateurs, and policymakers which would likely lead to the sharing of more knowledge on this issue. This also suggests the need for further campaigns that emphasize more educational actions directed at businesses as well as consumers.

5.2. Methods to tackle food waste

Most of the food business managers indicated that food waste was being measured, but further analyses or attempts to understand the implications were not made. None of the businesses knew about the information provided by the City of Berkeley on how to measure food waste, which illustrates just how prevalent and problematic the knowledge gaps exist between the food business services and the policy makers.

Furthermore, the methods for measuring food waste were solely visual and highly inaccurate. Visual measuring should not be considered an efficient method because accurate information cannot be gathered, especially from trash bags that are not transparent. This practice may allow restaurateurs to claim that only small amounts of food waste are being produced.

In addition, an in-vessel composting system was not used in any of the surveyed restaurants. Such systems process compost quickly on-site and come in a variety of sizes (Spencer, 2007), negating any space concerns. However, they do have high initial costs. The City of Berkeley does not provide financial incentives for owning compost-production systems.

5.3. Recommendations for action

All stakeholders can tackle and influence the food business, from the manager to the chefs and the waiters up to the customers in different ways. While purchasing less food to start with is one of the most significant ways to reduce food waste, there are a wide variety of steps that can be taken to reduce the amount of food waste. Recommendations mentioned from ReFED's “A roadmap to reduce U.S. food waste by 20 percent” that pertain to personnel in food service industry include (ReFED, 2016):

Food planning operations

- Measure the amounts of occurring food waste
- Offer different portions sizes or refilling options for consumers to choose after determining the amounts of consumer plate waste
- For buffet style places, rethink plate and tray sizes
- Review plate returns and work towards a reduction of unpopular food items
- Provide more options to set up meals and give an idea what could be included in a meal (dish of the day to use leftovers differently)
- Redesign the food supply chain to provide more possibilities for the use of existing foods in the food preparation
- Store food in the right places (e.g. lower/upper shelf in refrigerator) to keep those as long as possible
- Avoid over trimming while preparing bulk meat or fruits/vegetables

Staff and customer education

- Train staff for preparing meals with portion sizes that are not too large
- Better communication between staff and management to raise the awareness about food waste (consumer facing and back-end opportunities)
- Enhance communication with customers to create more sustainable attitude and demand among the guests by analyzing the desired menu choices

Business operator's incentives

- Reward/Provide certification for restaurants to promote sustainable behavior
- Consider collaboration with neighboring businesses to tackle food waste issues and eventually waste hauling collectively
- Adjust the size of bins or frequency that they are collected
- Redistribute surplus foods to local charities
- Plan appropriately and involve all staff members to not over purchase items

6. Conclusion

Our data suggests that the attitudes and behaviors around food waste in restaurants play major roles in the amounts of food discarded in restaurants. Policies and incentives are not likely to fully meet the challenge to reduce food waste (based on inferences from our data), but are needed to facilitate behavioral changes. Thus, access to information about how to prevent and manage food waste is likely the optimal strategy in reducing waste.

A key challenge was assessing the amounts of food waste produced because without assessment, further analysis on reduction potential and applicable solutions cannot be done. Time was also considered a limitation; many of the surveyed chain restaurants did not collaborate with any organizations to donate excess food because it was seen as an extra effort for the employees. More initiatives, often free of charge, led by organizations that support the reduction of food waste in dining places would be the most helpful step for restaurants. Redistributing surplus food in addition to giving customers portion size options would reduce waste, as would rewarding or promoting sustainable behavior in restaurants. The use of smaller landfill bins or the reduction of the hauling frequency would be a possible solution for reducing the creation of landfills and saving costs for disposal. Intergovernmental goals, such as the Sustainable Development Goals, will help address and tackle food waste and may even force certain stakeholders, such as food retailers, to deal with their leftovers.

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Appendices

Table 1
Survey Questions

Question Number	Questions	Responses
1	Position in the restaurant	Owner/Management/Chef/Cook/Other
2	Restaurant type	Individual (independent)/Chain (2–4)/Chain (5 or more stores)/Other
3	Number of seats in the restaurant	10–50/Other
4	Number of employees	1-3/4–6/7–15/16 or more
5	Types of offered meals	Daily the same/Daily same with few changes/Daily changing menus/Change monthly
6	Type of food	Mainly fresh produce food/Fresh produce and packed food/Mostly packed food/Other
7	Average lunch cost	$ 0–30/Other
8	Is the restaurant measuring amounts of food waste in any way?	Weighing/Visual/Measure what comes in (buy) vs. what goes out (waste)/None/Other
9	Are there separated compost bins for …	1 compost bin for all these kinds/Spoilage/Prepared food waste/Plate waste (consumer)/Other
10	How is inedible food waste disposed? *Inedible means, for example, spoiled food, inedible parts of fruits/vegetables, etc.	Compost bin/Compost compactor (in-vessel)/Compost outdoors (i.e. backyard)/Landfills/Other)
11	What is done with edible food waste? Multiple options possible	Give leftovers to staff/Donate to charities/Use for further meals/Compost/Landfills/Other
12	Are there reasons not to compost food waste in the restaurant?	No/Not sufficient waste generated/Costs/Space restrictions (for compost bins)/Other
13	Where does the compost go to?	Dispose in compost bin and haul/Donate (give away for free)/Sell/Landfills/Other
14	Are there actions for the staff to act more sustainable? If yes, what kind?	Yes (if yes, what kind?)/No/NA or Not Sure
15	Are there any campaigns targeting the customers to fight food waste?	Yes (if yes, what kind?)/No
16	Are customers asked to pack leftovers into doggybags (take-away boxes) offered by the restaurant?	Yes, always/Upon request/No
17	Is the fact about tax benefits when donating excess food a known thing? For more information, visit “Consolidated Appropriations Act, 2016”.	Yes/No
18	Is there collaboration with charities to donate surplus food? Multiple options possible.	None/Food Shift/Feeding Forward (now Copia)/Food Not Bombs/Other
19	Are there liability uncertainties in terms of donations?	Yes (if yes, explain)/No

Table 2
Characteristics of the Restaurants (N = 29).

Characteristics	Response Categories	N	%
Restaurant Type	Individual stores	22	76
	Chain (2-4 stores)	4	14
	Chain (5 or more stores)	3	10
Number of seats in the restaurant	10–50	19	66
	Other	10	34
Number of employees	1–3	1	3
	4–6	1	3
	7–15	14	49
	16 or more	13	45
Consultation Provided	Yes	9	31
	No	20	69
Total for each category		**29**	**100%**

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