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CONSUMER PERCEPTIONS AND BEHAVIORS TOWARDS FOOD WASTE REDUCTION – A TWO STUDY ANALYSIS IN OKLAHOMA

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Abstract

Almost 30% of food is wasted annually across the world from farm to fork. As a result, food waste has become a major sustainability challenge due to both direct and indirect impacts and implications related to food security, resource use, economic losses, and environmental degradation. Developed countries have been creating significantly more food waste with its resulting implications than developing countries. In high-income nations, such as the United States, it is the consumers that have been generating the most food waste relative to other food supply chain stages. The total percentage of food available at consumption level in high-income nations that becomes food waste is approximately 30% to 50%. It can mainly be explained with negligent consumption behavior, both at home and away from home. This research presents two studies conducted in Oklahoma that analyze consumer food waste behaviors.

The first study presents a new perspective on food waste behaviors subject to proximity to food source, which has not been addressed in this context in the literature. The conceptual novelty of the presented approach refers to three research subjects: 1) food provisioning routines (e.g. shopping, cooking, and storage), 2) food waste habits, and 3) food waste knowledge and opinions. Four consumer groups were determined and surveyed (customers at: a) large supermarkets/grocery stores, b) specialty grocery stores, c) farmers' markets, and d) community supported agriculture groups - CSA), to represent the conceptual 'distance' to food source (proximity to food source) based on the customers' connection with food production. Correlations and regression analysis were used to investigate differences in regard to food waste among those groups. Although the results show a clear congruence in food waste behavior among the analyzed groups regardless of proximity to food source, members of the CSA group were found to be more involved in food provisioning routines and exhibiting less wasteful behaviors.

The second study was designed to develop a novel index to measure the potential for food waste creation in university dining halls, called the Dining Hall Food Waste Indicator (DHFWI). Survey data collected from students, faculty, and staff at the University of Oklahoma (OU) were used to support the development of the DHFWI. Furthermore, the data were also used to analyze food choices and (dis)satisfaction about food availability, food waste habits and behaviors, and opinions on how OU could potentially reduce food waste in dining halls and thus enhance overall sustainability on campus. The results show a moderate to low potential for food waste creation among the surveyed group. A sub-indicator analysis revealed several notions expressed by the survey respondents to reduce dining hall food waste at OU, such as changing the dining hall environment (smaller portion sizes), targeting student knowledge and behavior (educational campaigns), and modifying student meal plan structures (allow meal points to carry over between weeks and academic school years).

Although the two studies represent different consumer groups, both provide insights into food waste perceptions, behaviors and potential amendments in food consumption patterns, which could be helpful with reducing food waste overall.

Chapter 1: Introduction

The number of studies focusing on food waste as one of the major sustainability issues across the world has increased substantially during the past two decades. Prior to a United States Department of Agriculture study by Kantor et al. (1997) there were very few published studies in the literature on food waste. Several of the prominent studies since 1997 have attempted to quantify global amounts of food waste from farm to fork or have quantified the resource requirements to produce those amounts of food waste and the accompanied environmental impacts (Gustavsson, Cederberg, Sonesson, van Otterdijk, & Meybeck, 2011; Kummu et al., 2012). Estimates of total food waste range from one-quarter to one-half of total agricultural production at different points along the global food supply chain each year, amounting to approximately 1.3 billion tons (Gustavsson et al., 2011; Lipinski et al., 2013; Lundqvist et al., 2008).

Although various studies differ in their estimates of precise levels of food waste generation across the globe, the general convention among them is that consumers in high-income nations are responsible for the largest share of food waste generation. Thus, addressing their food waste behaviors requires the most urgent attention (Parfitt et al., 2010). While both high- and low-income nations generate large quantities of food waste, they differ substantially in terms of where food waste occurs in the food supply chain. Poor infrastructure for post-harvest storage, handling, and distribution is the primary reason of food waste in developing countries. On the contrary, in developed countries, while significant amounts of food are lost early in the food supply chain due to out-grading from superficial appearance standards or unfavorable market conditions, negligent consumer behavior is responsible for the largest share of food waste. According to Gustavsson et al. (2011), consumers in developed countries waste approximately 95-115 kg/capita/year (209.4-253.5 pounds/capita/year), whereas consumers in developing countries waste only 6-11 kg/capita/year (13.2-24.2 pounds/capita/year).

Studies focusing on food waste in high-income nations, particularly the United States (US), have confirmed these assertions. Of the 110 billion pounds of food wasted in the US in 2012 consumers were responsible for 47 percent (Toth & Dou, 2016). According to Buzby & Hyman (2012) in terms of the annual economic value of food wasted in the US, food waste at the retail and consumption level is worth $165.6 billion, or $390/capita. Fruit and vegetables are the most wasted types of food, however, meat waste makes up over half of the value of consumer generated food waste ($197/capita/year). Such large amounts of food waste directly translate into wasted resources (such as water, energy, land) and unnecessary environmental impacts (CO2 and CH4 emissions) across the entire life cycle of food.

Consequently, the global food waste issue, and consumption level food waste in particular, requires solutions that are both relatively fast and very impactful. However, what many studies on food waste fail to provide is an in-depth explanation of what these solutions could be or how they might be achieved and implemented. This thesis combines two studies addressing this question in order to expand the literature in the field: 1) A study on consumer food waste in Norman, Oklahoma and 2) a study on food waste in dining halls at the University of Oklahoma. Although both studies are seemingly related to two very different aspects of consumption level food waste, they provide different perspectives on this problem from different consumer groups and in different consumption settings. Food waste at the

consumption level is not singular and can be represented by many different aspects (waste resulting from negligent behaviors, accidents when cooking food, time constraints, or poor food quality served) and situations (at home or away from the home). Both studies provide ideas and different perceptions about consumer food waste and can, thus, help with future researchto conceptualize solutions limiting wasteful consumer behaviors and ultimately reduce food waste.

Chapter 3 provides a research study analyzing food waste behaviors of surveyed consumers subject to their proximity to food source and the primary food purchasing place, i.e., supermarkets/large grocery stores, specialty grocery stores, farmers' markets, and community supported agriculture groups (CSA). The conceptual "proximity" or "distance" to food source is employed in an attempt to capture the connection, or lack of connection, between consumers and food production and any impact that this "proximity" has on mitigating negative behaviors leading to food waste.

Chapter 4 presents a study of consumer food waste behaviors in the main dining hall on the University of Oklahoma campus. The study had two primary goals: 1) development of an index to measure the potential for food waste creation in university dining halls, called the Dining Hall Food Waste Indicator (DHFWI) and 2) analysis of survey data to investigate students' perceptions and opinions on food choices, satisfaction and complaints about food availability, food waste habits and behaviors, as well as opinions on how the dining hall food waste situation could be improved, thus enhancing sustainability efforts on campus. .

Chapter 2: Research Context

Solutions to reduce food waste at every stage of the food supply chain are crucial in transitioning food systems to more sustainable forms. Nowadays, the major reasons for food waste drastically impacting and altering sustainability of food systems relate to environmental degradation and resource depletion, food insecurity, and economic losses. This applies particularly to food waste generated at the consumption level, which embodies the highest life cycle environmental, social, and economic costs among all food supply chain stages. It resonates from the fact that: 1) consumers are responsible for the highest percent of food waste in the entire food waste stream; as high as 47 – 61% in North America (Lipinski et al., 2013; Toth & Dou, 2016), and 2) food waste at consumption level carries the embodied resources (energy, water, land) from every other upstream food supply chain stage, including the resources needed to grow, process, and distribute food to its final destination. For example, a study by Kantor et al. (1997) found that food products are typically handled 33 times along the food supply chain before reaching consumers, which indicates how extremely extended most food supply chains have become and increases the accumulation of life cycle energy and material use. The impacts of those extended food supply chains on the creation of food waste in the United States (US) have been documented in many studies. According to Hall et al. (2009), 1400 kcal/capita/day (150 trillion kcal/year total) is wasted in the US, which represents a 50 percent increase of food waste along food supply chains since 1974. Behavioral choices by consumers in the United States that lead to food being wasted both in the home and away from the home have become prominent and there are no indications that the consumption level food waste issue is resolving. The following chapters present the research context on impacts and implications of food waste with the purpose to emphasize the need for food waste reduction at the consumption level.

2.1 Environmental Impacts of Food Waste

One of the most pressing concerns related to food waste arises from its environmental impacts. Food waste can cause a number of substantial issues that mostly relate to food farming in the first place as well as the final disposal of food waste. First, agriculture utilizes significant amounts of resources, mainly land, water, energy, and fertilizers and pesticides (mainly in artificial form). According to the FAO (2013), 30 percent of global agricultural land, or 1.4 billion hectares (3.4 billion acres), is used to grow food that is eventually wasted. Kummu et al. (2012) found that around 23 percent of global agricultural land is embedded in food waste. Similarly, 65 million acres, or 27 percent, of United States cropland is embedded in wasted food each year (Toth & Dou, 2016). The use of such large areas of land to grow food that is eventually wasted embodies both a loss of arable land that could otherwise be used to grow food that is diverted to those who need it. It also embodies the damaging aspects of conventional agricultural practices, particularly the use of fertilizers, pesticides, and monocultures. Moreover, because conventional agricultural practices dominate around the world, likely almost all of the 1.3 billion tons of annual food waste results in pollution from pesticides and over-fertilization (Gustavsson et al., 2011). Kummu et al. (2012) estimated that 23 percent of global fertilizer use is embodied in food waste. Global nitrogen inputs to grow wasted food average 2 pounds/capita/year, with Europe being the highest at 5.1 pounds/capita/year (Toth & Dou, 2016). Out of the three main fertilizer nutrients, nitrogen, phosphorous, and potassium (14.3 billion pounds, or 43 percent of applications) were used to grow wasted food in the US in 2012 (Toth & Dou, 2016). Crucially, nearly half

of nitrogen fertilizer applications are not utilized by plants and are emitted into the environment (Sage, 2011). According to Grizzetti et al. (2013), 35 percent of nitrogen emissions from fertilizers embodied in food waste volatize into the atmosphere (20 percent as nitrous oxide) and 65 percent runs-off into water systems, which causes eutrophication and contributes significantly to hypoxic zones.

Also water resources are overused as an outcome of food waste. On average, annual global water losses from food waste equate to 250 km^3 (~66 trillion gal) or approximately 24 percent of freshwater resources (FAO, 2013; Kummu et al., 2012). Embodied water losses from food waste in the US are also around one-quarter of the total water used for agricultural irrigation purposes, or 18 trillion gallons (Hall et al., 2009; Toth & Dou, 2016). Chapagain & James (2011) found that the water footprint of food waste in the United Kingdom (UK) was around 6 percent of irrigated water requirements, which is 1.638 billion gal or 64.2 gal/capita/day, in 2009. This is much less than in the United States, however, the UK has a much smaller population.

Furthermore, food waste is responsible for significant levels of life cycle energy use and greenhouse gas emissions. Globally, 3.3 Gtons of carbon dioxide equivalent emissions are generated annually due to food waste, before accounting for land-use change associated with agriculture that could raise total emissions by 25 to 40 percent (FAO, 2013). Two percent of total US energy usage and greenhouse gas emissions result from food waste each year, worth $198 million (Cuéllar & Webber, 2010; Venkat, 2012). Hall et al. (2009) calculated that energy usage in the US embedded in food waste equals approximately 300 million barrels of oil annually. Lastly, the anaerobic decomposition of food waste in landfills has severe consequences in terms of methane emissions, considering that 97 percent of uneaten food in the US is sent to landfills.

2.2 Social Impacts of Food waste

The major issues regarding social impacts of food waste are centered on food insecurity, the equitable distribution of food around the world, and health problems in high-income nations. There are currently close to one billion people worldwide with compromised food security and an additional one billion people suffering from micronutrient deficiencies ("hidden hunger") in their diets (Godfray et al., 2010). Food security is defined as the ability to access healthy, affordable, and culturally appropriate foods at all times to enable each individual to live an active, healthy, and productive life (FAO, 2003). Conversely, food insecurity is the lack of ability to acquire healthy, affordable food due to financial or social constraints (Coleman-Jensen et al., 2014). Additionally, the human population is expected to increase and reach nine billion people on the planet by 2050, which could require a 60-100% increase in food production in order to feed the world population (Godfray et al., 2010; FAO, 2017). These statistics need to be considered within the same context and at the same time as food waste is discussed, considering that 1.3 billion tons of food is wasted each year (Gustavsson et al., 2011; Kummu et al., 2012; Lipinski et al., 2013; Lundqvist et al., 2008). Despite the levels of global food waste, in 2007 the world produced an average of 2,770 kcal/person/day after food waste and non-food uses such as animal feed or bioenergy were subtracted (Alexandratos & Bruinsma, 2012). When food is wasted, however, the demand for food theoretically increases and there are far fewer of the remaining calories available for vulnerable populations. Several authors argue that food waste should include all edible food

diverted from food supply chains such as crops used for animal feed and bioenergy (Chaboud & Daviron, 2017; Stuart, 2009). For example, three billion people could be fed an adequate vegetarian diet with the energy content in the 700 million tons of cereal and legumes fed to livestock annually (Smil, 2002). Moreover, consumers in the United States waste around 50 percent of available calories from meat (Toth & Dou, 2016), which raises significant ethical questions when considering the number of food insecure people in the world and the resource intensity of animal husbandry. Lastly, it is important to remember that food waste in high-income nations is partially a result of food surplus. Smil (2004) calculated that 700 million people could be fed with an adequate vegetarian diet based on the food surplus in high-income nations. Both Smil (2004) and Hall et al. (2009) argue that the over-consumption of this food surplus, which has contributed to the obesity epidemic and other health related issues, should also be considered food waste; while addressing food oversupply would decrease food waste substantially and improve health outcomes in the end.

2.3 Economic Impacts of Food Waste

Economic losses from food waste are directly caused by the use of production factors and resources in agricultural production, processing, distribution, retail, and consumption. The prices that consumers pay for their food also contribute substantially to economics of food waste, although the true costs of energy and other resources used in upstream supply chain stages are rarely included in this total cost. Globally, the 1.3 billion tons of annual food waste is worth approximately $990 billion, of which $680 billion are incurred in high-income developed nations and $310 billion are attributed to lower-income developing nations (FAO, 2018). In the US, the total value of the 133 billion pounds of food waste as purchased at the consumption stage was worth $161.6 billion in 2010 (Buzby et al., 2014). The same study found that the most costly food groups (in terms of economic losses) in the total food waste stream in 2010 were meat waste ($48 billion), vegetables ($30 billion), and dairy ($27 billion). Another study found that the resources used to produce uneaten food in the United States alone are worth $59.5 billion to $71.4 billion (Ziolkowska, 2017). Wasted meat is not only the most costly food group as purchased at retail prices, but it also embodies the most life cycle economic costs due to the high resource input in animal husbandry. The main resources used in animal husbandry in the US, water, land, and energy, embodied in wasted meat are worth around $27.5 billion. Considering environmental costs of methane and nitrous oxide emissions in addition, the total economic costs of wasted meat rise to around $32.5 billion (Hardersen & Ziolkowska, 2018). Due to the fact that consumers in the United States are responsible for the largest proportion of food waste, ~47% (Toth & Dou, 2016), they are also responsible for the majority of economic and environmental costs from food waste and likely incur high per capita losses every year. Buzby and Hyman (2012) calculated that these per capita losses were worth $1.07/day.

The following two studies presented in chapter 3 and 4 focus on different perceptions on food waste by different consumer groups in a local community in Norman in Oklahoma. They also delineate possible food waste reduction options, subject to socio-economic factors in households and customers of dining halls on the University of Oklahoma campus.

Chapter 3: Does Proximity to Food Source Influence Food Waste Behavior?

Abstract

Almost 30% of food is wasted annually across the world from farm to fork. In high-income countries, consumers are responsible for nearly 50% of total food waste. So far, research related to consumer food waste has been limited, mainly due to missing data and information, while most studies analyze quantities of generated food waste or specific behaviors leading to food waste, irrespective of where the food was purchased.

This research presents a new perspective on food waste behaviors subject to proximity to food source based on a study in Oklahoma in the United States. The novelty of the presented approach refers to three research subjects: 1) food provisioning routines (e.g. shopping, cooking, and storage), 2) food waste habits, and 3) food waste knowledge and opinions.

Four consumer groups were determined and surveyed (buyers at: a) large supermarkets/grocery stores, b) specialty grocery stores, c) farmers' markets, and d) community supported agriculture groups - CSA), to represent the conceptual 'distance' to food source (proximity to food source) based on the customers' connection with food production.

The results show a clear congruence in food waste behavior among the analyzed groups regardless of the proximity to food source (i.e., shopping habits). However, members of CSA groups were found to be more involved in food provisioning routines and exhibit less wasteful behaviors. The results point towards future research needs and analyzing localized food systems and groups similar to CSA more closely for potential elimination or stricter reduction of food waste.

Keywords: Food waste, sustainability, consumers, regression

3.1 Introduction

Food waste is increasingly becoming a major obstacle in achieving environmental, social, and economic sustainability. Estimates suggest that 25-50% of global agricultural food production (~1.3 billion tons) is wasted along food supply chains every year (Gustavsson et al., 2011; Kummu et al., 2012; Lipinski et al., 2013; Lundqvist et al., 2008). Food waste has significant implications on natural resources (e.g., water, energy, land) that are directly embedded in wasted food.

In high-income countries annual food waste has been recorded to average 95-115 kg/capita (209.4-253.5 lbs/capita) (Gustavsson et al., 2011). In the United States (US), ~47% of food (110 billion pounds) waste occurred at the consumption stage in 2012 (Toth & Dou, 2016). In addition, 45 billion pounds of food is wasted at retail level, which in 2008 alone was worth $165.6 billion (i.e., $390/per capita) (Buzby & Hyman, 2012). Those extreme levels of food waste in the US are antithetical to low-income countries wasting ~6-11 kg/capita/year (13.2-24.2 lbs/capita/year) (Gustavsson et al., 2011). Most food waste in those countries occurs mainly due to poor infrastructure for post-harvest storage, handling, and distribution. Several authors have discussed excessive food surplus in high-income countries (and lack thereof in low-income countries) as a root cause of negligent behaviors by consumers leading to food waste (Mourad, 2016; Papargyropoulou et al., 2014; Smil, 2004). As a result, this excessive

food surplus coupled with progressing globalization, industrialization, and urbanization of food chains has led to a disconnection between people and food production (Mourad, 2016; Rutten, 2013; Spooner, 2016).

Several authors argued that suppressing food surplus through policy measures could help mitigate negligent food waste behaviors (Hall et al., 2009; Mourad, 2016; Papargyropoulou et al., 2014). In this way, Western societies would be forced to reevaluate their relationship to food, which could result in lower food waste levels. However, Bellemare et al. (2017) stated that implementing policies aimed at reducing food supply could raise prices and aggravate food insecurity. Instead, the authors suggested that policy efforts should target the respective food supply chain stages where the costs of food waste are the highest, especially the downstream stages such as retail and consumption (Bellemare et al., 2017). This strategy, further debated by Mourad (2016), may not result in meaningful long-term societal changes and would also fail to address environmental degradation associated with food waste. Shepon et al. (2018) claimed that replacing all animal-based items in the US diet with plant-based alternatives would provide enough food to feed 350 million additional people, which would thus highly exceed the expected benefits of eliminating all supply chain food waste. Regardless of the specific policy mechanisms theorized to be the most effective at reducing food waste it is clear that social institutions, norms, and cultural values of businesses and consumers need to be analyzed and addressed before any change can take place.

The disconnect and separation between consumers and food production and the related impacts on food waste have been documented in a number of studies addressing consumer behaviors, attitudes, habits, and perceptions in western societies (Graham-Rowe et al., 2014; Hartmire et al., 2016; Koivupuro et al., 2012; Lyndhurst et al., 2007; Moscato and Stanton, 2016; Neff et al., 2015; Parizeau et al., 2015; Quested etal., 2013; Refsgaard and Magnussen, 2009; Spooner, 2016; Watson and Meah, 2012). Parfitt et al. (2010, p. 3078) forecast that the majority of food waste will continue to be produced in the post-consumer stage, driven by: low prices of food relative to disposable income, consumers' high expectations of food cosmetic standards, and the disconnection between consumers and the food production process. Looking specifically at different products, Buzby et al. (2011) found that fruit and vegetable losses at retail and consumer stages in 2008 were most significant, and amounted to $15.1 billion and $27.7 billion, respectively. They found that consumers did not seem to be concerned either by food loss itself or the perceived cost of this waste mainly due to an abundance of affordable food. The culture of grocery store shopping in the United States directly relates to this disconnection between consumers and producers. On the one hand, grocery stores can be viewed as representative of consumerism and convenience, thus generating a false sense of abundance. On the other, anonymous shopping experiences with foods delivered from distant regions (or online grocery shopping) create a disconnect between people and food production.

A significant research contribution on food waste has been generated in the United Kingdom (UK). Concerted initiatives and campaigns (e.g., "Love Food, Hate Waste") contributed to the reduction of food waste at the retail and consumer stages as far as 21% between 2007 and 2012 (Quested and Johnson, 2012). In a related study, Quested et al. (2013) found that the generation of food waste should be viewed as a result of multiple behaviors that can increase the likelihood or amount of food being wasted (not just one single behavior). In addition, the study found that economic motives and guilt are among the biggest factors for consumers to reduce food waste. Environmental concerns generally do not motivate consumers to reduce food waste, nor do consumers ponder over environmental implications when discarding edible food. Thus, the findings suggest that relying on environmental concerns in the process of educating the public about the need of food waste reduction will most likely have limited

impact as a single intervention measure, especially due to limited public environmental knowledge (Robelia and Murphy, 2012; Watson and Meah, 2012; Stefan et al., 2013). However, those findings should not understate the importance of public education on food waste, specifically in regard to environmental impacts. Robelia and Murphy (2012) found that environmental literate persons are significantly more likely to engage in pro-environment activities than individuals uneducated about the environment. Thus, combining educational activities in regard to both environmental impacts and household economic consequences of food waste could prove to be most effective to the public at large. This may incentivize consumers to examine their food waste habits and ultimately adjust or even change their food waste behaviors.

3.2 Research Objective

Many studies have indicated a disconnect and devaluation between consumers and food, which is further perpetuating food waste (Mourad, 2016; Neff et al., 2015; Parfitt, 2010; Parizeau et al., 2015; Quested et al., 2013; Spooner, 2016). This study adds to the discussion in the field by proposing a new analysis perspective comparing specific food provisioning routines with different food waste behaviors based on their proximity to food source. To investigate these interdependencies, this study tested the following hypotheses:

1) Consumers participating in shorter food supply chains (i.e., farmers' market and community supported agriculture consumers) are more involved in food provisioning and waste less food in their households than consumers involved in longer food supply chains (i.e., buyers at supermarkets and specialty grocery stores), and
2) The CSA consumers are most involved in food provisioning and generate the least food waste compared to other analyzed groups.

While other studies examined consumer food waste behavior in general terms, to our knowledge no studies exist on relations between food waste behavior and proximity to food source for a multitude of diverse consumer groups.

3.3 Methodology and Data

Survey design and sample

For the purpose of this study, anonymous online surveys were conducted between June and July of 2017 by means of the Qualtrics platform. The survey questions related to food provisioning, food waste behavior and knowledge, attitudes towards local foods, and socio-demographic characteristics of the respondents. Four groups of consumers were distinguished to represent different food supply chains, as follows: a) large supermarkets/grocery stores, b) specialty grocery stores, c) farmers' markets, and d) community supported agriculture (CSA) groups.

The total of 300 survey links were distributed in person to consumers shopping at farmers' markets in Norman, OK and Oklahoma City farmers' markets (150 people), specialty grocery stores (Natural Grocers in Norman, OK) (75 people), and large supermarkets/grocery stores (Homeland in Norman, OK) (75 people). In addition, 13 CSA farmers in Oklahoma were contacted with a request to distribute survey links to their cooperative members. In response, 117 surveys were received (including 37 surveys from the CSA members) at the response rate of ~39%. This response rate does not include the CSA member surveys, as due to the

anonymity of the surveying method undertaken, calculating the total number of distributed surveys to CSA members was not possible.

The survey data was cleaned, coded, and separated for the four consumer groups based on the survey question related to the percentage of their food origin. Due to the multifaceted nature of shopping routines (and many consumers purchasing their food at different places), the process of data sorting and group division was not straightforward, and required conceptual concessions. Accordingly, a consumer purchasing food from any one of the four groups was placed in each data set for those respective groups. Ultimately, the data sets with the consumer groups were comprised as follows: supermarkets/large grocery stores (104 respondents), specialty grocery stores (96 respondents), farmers' markets (80 respondents), and CSAs (37 respondents).

The separation process for the four groups was undertaken with the aim to represent each store category as occupying a specific space upon a spectrum related to the proximity of consumers and food production. Group A (large supermarkets/grocery stores) is defined and understood as representative of a total separation between consumers and food production. This is due to anonymous shopping experiences that large supermarkets and grocery stores provide with food shipped in from around the world, and with no link to the production place or to the producer (i.e., farmer). Group B (specialty grocery stores, such as Natural Grocers, Whole Foods, Sprout's) provide an anonymous shopping experience with food often shipped in from distant locations. However, by offering organic, sustainably grown, and fair trade products, they are indicative of higher connectives with consumer health and well-being as well as with environmental concerns. Groups C and D (farmers' markets and community supported agriculture groups) occupy spaces much closer to food production in the food supply chain as compared to the other two categories. Consumers shopping at farmers' markets are directly and personally connected to farmers selling their food at a farmers' market. However, farmers' market consumers are also very likely to purchase a large share of their food at grocery stores (large supermarkets or specialty stores). Finally, consumers who are members of CSA groups are defined and understood as fully connected to food production and distribution through a socially embedded contract with a specific farmer growing their food in a local proximity. Thus, they are distinct from all other groups due to their involvement in a short food supply chain that seeks to "decommodify" food. Hence, large supermarkets/grocery stores promote high marketness and instrumentalism focused mainly on net margins, while CSAs represent low levels of marketness and instrumentalism and focus instead on personal relationships, social equity, and environmental stewardship in addition to optimizing net margins (Galt, 2013; Hinrichs, 2000; Kirwan, 2004).

Data analysis

Two questions were analyzed and statistically tested with this study: 1) What factors are driving food provisioning routines subject to demographic characteristics of the studied consumer groups? and 2) What food provisioning routines are driving food waste behaviors of those consumers?

To answer the first question, the following demographic variables were used: education level, gender, age, household income, household size, and number of adults in the household. Survey questions related to food shopping and cooking routines included: times of grocery shopping per month, money spent on groceries per month, money spent on non-grocery foods per month, person in the household shopping for food, special dietary plans in place in the household, person in the household cooking food, and number of days per week when meals are cooked in the household from scratch.

For the second question on food provisioning routines driving food waste behaviors, the following specific survey questions were asked: willingness to consume foods past sell-by or expiration dates, feelings of guilt associated with food disposal, efforts made by the respondents to reduce food waste, frequency of purchasing buy-one-get-one-free offers, frequency of stockpiling foods in the refrigerator, frequency of losing track of foods in the refrigerator, and efforts to plan meals and estimate food needs before grocery shopping.

Some of the questions formulated to describe food waste behaviors could also be used for analyzing food provisioning routines. However, based on information found in the literature these behaviors were identified as specific actions or modes of thought that may directly lead to food waste. Therefore, in this study they are treated as a separate group of variables to food provisioning routines.

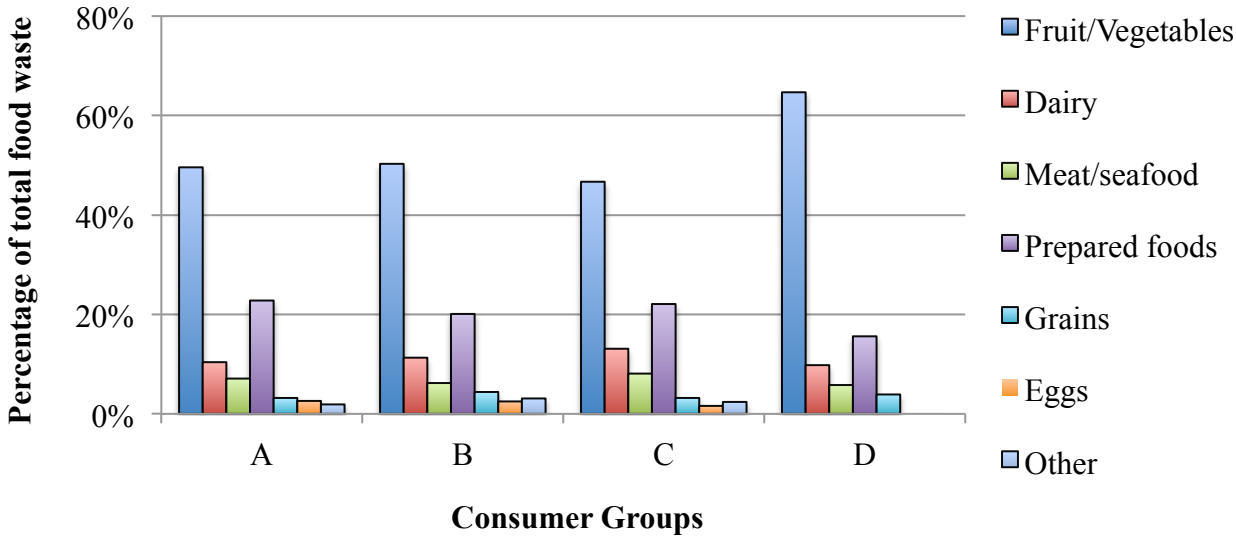
Each variable describing food provisioning routines was tested for potential correlations with demographic variables and also with the remaining food provisioning variables. Additionally, variables describing food waste behavior were tested for correlations with all food provisioning variables. Point-biserial correlation tests were conducted to analyze relationships between several dichotomous food provisioning variables and continuous food provisioning variables as well as food waste behavior variables, which will be discussed in detail in the results section. Each continuous variable used in the point-biserial correlations passed necessary assumptions of normality and homoscedasticity. Linear regression was further used to examine the degree of impact of demographic characteristics and some food provisioning behaviors on other continuous food provisioning variables, while food provisioning variables were further used to examine their impact on food waste behavior variables. Questions without continuous data points were coded as binary variables in the regression models.

3.4 Results

Food waste triggers, patterns and perceptions

The results of the survey show that in all groups more than 75% of consumers believe their food waste to be extremely low (0-10% of total purchased food). Fruit and vegetables were found to be the type of food discarded most frequently by consumers in each group, at ~50% in the farmers' market, specialty grocery store, and supermarket/large grocery store groups, while at 65% in the CSA group (Fig. 1). The second most frequently discarded type of food was 'prepared foods' at different levels varying between 16% and 23% among the individual groups. Dairy (~10%) and meat/seafood (~7%) made up a much smaller portion of foods discarded in each group. Other foods were wasted at a lower rate, which can be explained with their type (foods with low perishability and long shelf-live, e.g. grains or foods consumed at lower quantities in general, e.g., nuts).

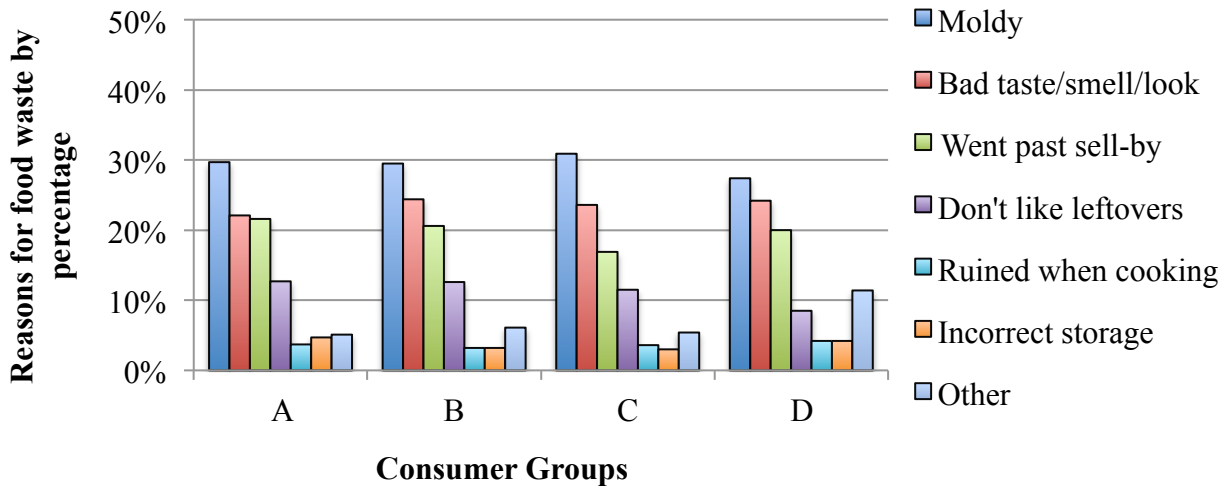
Figure 1 Food type discarded most frequently by consumer group



Note: A = Supermarket/large grocery store. B = Specialty grocery store. C = Farmers' market. D = CSA

For all four groups three specific reasons determine consumers' food waste behavior most: perishability (food becoming moldy, i.e., non-edible) (~30%), bad taste, smell or look (~25%), and past sell-by or expiration date (~20%). For ~10% of consumers the food waste was caused by overly cooking habits generating leftovers they did not feel like consuming in the end (Fig. 2).

Figure 2 Reasons for food waste in households



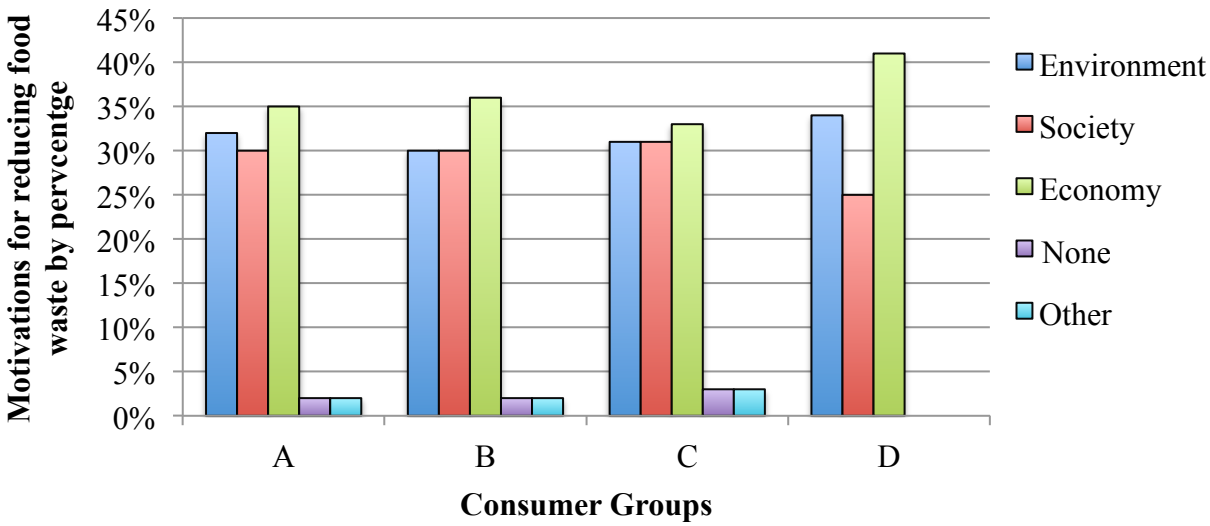
Note: A = Supermarket/large grocery store. B = Specialty grocery store. C = Farmers' market. D = CSA

Furthermore, in terms of consumers' perceptions regarding harm to the environment and natural resources generated by food waste, the results revealed normal standard distributions and very small differences among the groups, with most responses indicating 'neutral' or

'moderately harmful' impact. Less than 4% of consumers in each group believed that food waste was 'not at all harmful' to the environment. Conversely, a much larger percentage of consumers (slightly below 20% in each group) perceived food waste as 'extremely harmful' to the environment. Consumer interest in learning about ways to reduce food waste showed normal distributions for the first three groups, and a bimodal distribution for the CSA group. In the supermarket/large grocery stores, specialty grocery stores, and farmers' market groups 54-57% of responses indicated "moderately interested" or "very interested". CSA group consumers were more split with 25% indicating only "slightly interested" and 33% indicating "very interested". More specifically, 28-33% of the consumers in all groups were 'very interested', 3-9% had no interest, while 15-19% were 'extremely interested' in learning more about food waste reduction.

Finally, consumers were found to feel strongly about economic and environmental aspects of food waste, with 33-41% accounted for economic motives in each group, followed by environmental motives (30-34%), and social motives (25-30%). Average assessments as response to other survey questions have been summarized in Tab. 1.

Figure 3 Motivation for food waste reduction



Note: A = Supermarket/large grocery store. B = Specialty grocery store. C = Farmers' market. D = CSA

Table 1 Average estimates of food provisioning and food waste behavior responses

	CSA	Farmers' market	Specialty grocery store	Supermarket/large grocery store
Food provisioning variables				
Number of times grocery shopping per month	7.08	7.23	6.93	6.3
Money spent grocery shopping per month ($)	464.03	430.06	416.67	398.54
Money spent on non-grocery food per month ($)	210.35	220.5	210.72	210
Days cooking per week	5.35	4.82	4.71	4.61
Willingness to eat past sell-by or expiration dates (scale: 0-5)	3.17	2.89	2.91	2.88
Perceived feeling of guilt when wasting food (scale: 0-5)	3.33	3.16	3.3	3.19
Food waste behavior variables				
Perceived effort to reduce food waste (scale: 0-5)	4.22	3.87	3.89	3.9
Frequency of purchasing buy-one-get-one-free promotions (scale: 0-5)	2.25	2.42	2.44	2.44
Frequency of stockpiling foods when grocery shopping (scale: 0-5)	2.39	2.52	2.54	2.47
Frequency of losing track of foods in refrigerator (scale: 0-5)	2.5	2.63	2.68	2.67
Perceived effort to plan meals before grocery shopping (scale: 0-5)	3.58	3.57	3.51	3.44

Regression results

Before analyzing the data for possible variable interdependencies, correlation tests were conducted for the respective data sets for each group. First, food provisioning variables were tested for correlation with demographic variables to determine what factors were driving consumers' food provisioning routines. Second, food waste behavior variables were tested for correlations with food provisioning variables to determine if food provisioning routines had any relationship to behaviors ultimately leading to food waste. Only correlations greater than or equal to 0.30 were further considered for the following regression analyses. In a next step, linear multiple regression models were developed for all quantitative continuous food provisioning and food waste behavior variables (table 2-7).

For food provisioning analysis four independent variables were used: times grocery shopping per month, money spent grocery shopping per month, money spent on non-grocery food per month, and days cooking per week. Models with an R^2 value greater than 0.20 were found in all groups for two variables: money spent grocery shopping per month and money spent on non-grocery food per month. Only in the CSA group an R^2 value greater than 0.20 was found for the variable 'days cooking per week'. No significant models were found for the variable describing times spent on grocery shopping per month. The dependent variables money spent on grocery shopping per month and money spent on non-grocery food per month indicated the highest R^2 values of 0.66 for all groups and 0.53 for the CSA group.

In all regression models considering money spent on grocery shopping per month as a dependent variable, the most significant independent variable with an impact on the dependent variable was money spent on non-grocery food per month. For every dollar increase in money spent on non-grocery food there was an increase in money spent on groceries that ranged from ~$0.50-$0.85 among all groups. This is an expected result and an economic effect of a potential increase in household income. Only the household income variable showed statistical significance in the CSA group and specialty grocery store group. In the CSA group, each increase in the indicated income level resulted in a following increase of $96.60 spent on grocery shopping per month, while it amounted to $38.17 in the specialty grocery store group.

Household size had varying levels of impact in three groups (CSA, specialty grocery store, and supermarket/large grocery store). With each additional person per household the amount of money spent on grocery shopping increased by $46.08 in the supermarket/large grocery store group, $102.74 in the specialty grocery store group, and $73.20 in the CSA group.

The number of days cooking per week had an impact on money spent on grocery shopping solely in the CSA group with an increase by $61.45 subject to each additional cooking day per week. Lastly, the only model containing days cooking per week as a dependent variable was in the CSA group with R^2=0.39. Two independent variables were included: person cooking meals (if the food shopper is responsible for cooking, an increase in cooking days per week was noted) and adults living in the household (with one additional adult, the frequency of cooking in a household decreased by one day).

Table 2 Linear regression results for CSA group and food provisioning variables

Dependent Variables	Independent Variables	Independent Variable Coefficients	R^2	Constant	Std. Error	Model p-value (alpha < 0.10)
Money spent grocery shopping per month	Money spent on non-grocery food per month	0.84****	0.66	-611.70	178.82	< 0.001
	Days cooking per week	61.45***				
	Household income	96.60***				
	Household size	73.20*				
Money spent on non-grocery food per month	Money spent grocery shopping per month	0.34****	0.53	-165.83	113.50	< 0.001
	Adults in household	110.03***				
Days cooking per week	Who cooks your food[a]	1.32**	0.39	6.35	1.25	< 0.001
	Adults in household	-0.99**				

Note: [a]Who cooks your food: 0 = someone else, 1 = myself. *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

Table 3 Linear regression results for farmers' market group and food provisioning variables

Dependent Variables	Independent Variables	Independent Variable Coefficients	R^2	Constant	Std. Error	Model p-value (alpha < 0.10)
Money spent grocery shopping per month	Money spent on non-grocery food per month	0.63****	0.23	0.63	219.31	< 0.001
Money spent on non-grocery food per month	Money spent grocery shopping per month	0.21***	0.39	-16.58	150.33	< 0.001
	Days cooking per week	-25.22**				
	Household income	46.40				
	Household size	36.08				

Note: *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

Table 4 Linear regression results for specialty grocery store group and food provisioning variables

Dependent Variables	Independent Variables	Independent Variable Coefficients	R^2	Constant	Std. Error	Model p-value (alpha < 0.10)
Money spent grocery shopping per month	Money spent on non-grocery food per month	0.47****	0.37	162.92	198.70	< 0.001
	Household income	38.17**				
	Household size	102.74****				
	Adults in household	-121.17**				
Money spent on non-grocery food per month	Money spent grocery shopping per month	0.30****	0.34	17.54	146.07	< 0.001
	Days cooking per week	-18.06**				
	Household income	39.19***				

Note: *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

Table 5 Linear regression results for supermarket/large grocery store group and food provisioning variables

Dependent Variables	Independent Variables	Independent Variable Coefficients	R^2	Constant	Std. Error	Model p-value (alpha < 0.10)
Money spent grocery shopping per month	Money spent on non-grocery food per month	0.66****	0.33	156.54	193.93	< 0.001
	Household size	46.08**				
Money spent on non-grocery food per month	Money spent grocery shopping per month	0.35****	0.41	12.71	138.50	< 0.001
	Days cooking per week	-23.08***				
	Household income	42.59***				

Note: *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

Most of the regression models including food waste behavior variables as the dependent variable showed insignificant R^2 values (<0.20) and, thus, they were not included in the result tables presented below. However, a discussion of some of these results was provided in the following section of this paper due to potential contextual implications of those outcomes. In addition to the CSA group model, only one model for the farmers' market group was developed with the R^2 value greater than 0.20. This model tested factors impacting the frequency of purchasing buy-one-get-one-free promotions, such as person cooking meals and the household income. Both variables had a negative impact on the dependent variable. Four regression models were developed for the CSA group; three of them were simple regression models with the following results. An increase in household size caused a decrease in the willingness to consume food past sell-by or expiration dates by 0.63 points (scale: 0-5). Moreover, the person in charge of cooking meals had a significant impact on the frequency of losing track of foods in refrigerator (coefficient = -0.70) (scale: 0-5) and perceived effort to plan meals before grocery shopping (coefficient = 1.23) (scale: 0-5). These results shows that consumers who are in charge of cooking their household's meals are better able to manage household food stocks and plan additional food needs when shopping, so as to reduce the possibility of food waste generation. Perceived feeling of guilt when wasting food was significantly impacted by two variables: person in charge of grocery shopping (coefficient = -0.76) (scale: 0-5) and number of cooking days per week (coefficient = 0.23) (scale: 0-5). An unusual contradiction is found in these two results, as consumers who shop for their own

food feel less guilty about wasting food, while those consumers who cook more days per week have more guilt about wasting food.

Table 6 Linear regression results for CSA group and food waste behavior variables

Dependent Variables	**Independent Variables**	**Independent Variable Coefficients**	**R^2**	**Constant**	**Std. Error**	**Model p-value (alpha < 0.10)**
Willingness to eat past sell-by or expiration dates	Household size	-0.63***	0.27	4.72	1.04	< 0.01
Frequency of losing track of foods in refrigerator	Who cooks your food[a]	-0.70***	0.20	3	0.67	< 0.01
Perceived effort to plan meals before grocery shopping	Who cooks your food[a]	1.23****	0.33	2.72	0.83	< 0.001
Perceived feeling of guilt when wasting food	Who does your grocery shopping[b]	-0.76**	0.22	2.63	0.76	< 0.05
	Days cooking per week	0.23**				

Note: : [a]Who cooks your food: 0 = someone else, 1 = myself. [b]Who does your grocery shopping: 0 = someone else, 1 = myself. *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

Table 7 Linear regression results for farmers' market group and food waste behavior variables

Dependent Variables	Independent Variables	Independent Variable Coefficients	R^2	Constant	Std. Error	Model p-value (alpha < 0.10)
Frequency of purchasing buy-one-get-one-free promotions	Who cooks your food[a]	-0.62****	0.20	3.57	0.60	< 0.001
	Household income	-0.16***				

Note: [a]Who cooks your food: 0 = someone else, 1 = myself. *p < 0.10. **p < 0.05. ***p < 0.01. ****p < 0.001.

3.5 Discussion

The results of the study suggest that: a) the first hypothesis tested in this paper (Consumers participating in shorter food supply chains are more involved in food provisioning and waste less food in their households) be rejected, and b) the second hypothesis (CSA consumers are most involved in food provisioning and generate the least food waste among other analyzed groups) be accepted.

The results are not obviously conclusive that proximity to food source results in reduced food waste. However, clear differences have been found between the CSA group and the other three groups in terms of food provisioning routines and food waste behaviors. The perceptions of the study participants across all groups about their food waste habits were very similar and overwhelmingly indicated a belief of very low self-generated food waste. As also indicated in the literature, it needs to be emphasized, that questions about consumers' own food waste should not be taken literally. Nevertheless, they can be useful for gaining insights into American perceptions of their food waste levels as well as for comparing the findings with evidence-based averages about national food waste (Neff et al., 2015, p. 98). The findings of this study in regard to perceived/ stated assessments about food waste levels conform with other studies showing consumers believe their personal food waste is very low (Neff et al., 2015), which can be theoretically explained by missing awareness about food waste and the actual disposal amounts. In reality however, the total amount of consumption level food waste in the United States suggests that consumers are greatly underestimating the amount of food they waste (Buzby et al., 2011; Buzby & Hyman, 2012; Gustavsson et al., 2011; Parfit et al., 2012; Quested et al., 2013; Toth & Dou, 2016).

Fruit and vegetables were by far the most frequently disposed types of food in each surveyed group, while food perishability (and mold) was found to be among the most prominent reasons for food disposal and waste. This is straightforward due to high perishability (and short lifespan) of fruit and vegetables. These outcomes also overlap with results of other studies in the literature at the national and international level (Buzby et al., 2011; Gustavsson et al., 2011).

In terms of food waste knowledge, consumers in each group were rather congruent in their opinions about a moderately harmful impact of food waste on the environment and natural resources. This raises an interesting point about the awareness and/or education regarding food waste and environmental implications (both in the stage of food production and as a result of food disposal). There is sufficient evidence in the literature to prove that food waste can be extremely harmful to the environment. Studies have shown that with discarded food, large amounts of land, water, energy, and fertilizers are also wasted that went into the production of those foods (Grizzetti et al., 2013; Hall et al., 2009; Kummu et al., 2012; Toth and Dou, 2016). Moreover, environmental degradation and depletion stem from wasted resources in combination with intensive production methods widely used around the world. Approximately one quarter of global freshwater resources, cropland, and fertilizers is embedded in food waste (Kummu et al., 2012). Greenhouse gas emissions are also a significant issue resulting from food waste (Cuéllar & Webber, 2010; FAO, 2013; Venkat, 2012; Ziolkowska, 2017). Also, ecosystem services can be affected, not necessarily due to food disposal but rather as a result of intensive agricultural production methods and the embedded resources lost due to food waste. As a result, degradation of ecosystem services can cause negative effects on agricultural productivity (Dale & Polasky, 2007).

The results indicate an important opportunity to address the need for improved education about food waste, especially as the willingness and interest to learn about those issues undoubtedly exist among the surveyed consumers. Considering consumer motives to reduce their food waste, the results again provide valuable insights into potential educational avenues. Economic motives, i.e., loss of money when food is discarded in a household, were mentioned most frequently in each group as the most important factor for reducing food waste. Previous studies in the literature have also proven this finding (Aschemann-Witzel et al., 2015; Bamberg and Moser, 2007; Evans, 2011; Evans, 2012; Kollmuss and Agyeman, 2002; Neff et al., 2015; Parizeau et al., 2015; Quested et al., 2013; Stefan et al., 2013; Watson and Meah, 2012). However, environmental and social concerns about food waste impacts still made 30-34% and 25-30% of the responses, respectively. Utilizing a broad sustainability platform addressing the three sustainability pillars simultaneously (i.e., economic, environmental, and social) would most likely produce the most beneficial outcomes to balance resource use in the food supply chain constituting consumers.

Numerous studies in the literature highlighted correlations between food provisioning, the connection with consumed food both on food waste and on their ability to understand their food waste behaviors (Hartmire et al., 2016; Lyndhurst et al., 2007; Parizeau, 2015; Quested et al., 2013). Spooner (2016, p. 83) asserted that *"the further separation of the functions of production, supply, distribution, preparation, and consumption increases the potential for waste"*. This recognition proves the major benefit of short food supply chains as consumers are more capable of gaining food appreciation and knowledge due to their regular face-to-face interactions with food producers (Hinrichs, 2000; Kirwan, 2004, 2006). A study by Lyndhurst et al. (2007) found that only one in four consumers in the United Kingdom was comfortable with their own food provisioning skills such as meal planning and dealing with leftovers. Additionally, only 13% of consumers were found to be receptive to the food waste issue and actively engaged in reducing their own food waste. Furthermore, Parizeau (2015) observed that consumers cooking from scratch more often spent less money on non-grocery food. They also found a positive correlation between the amount of money spent on non-grocery food and the amount of per capita organic waste produced. Parizeau (2015) concluded that cultural changes that engender food and waste awareness are a major mechanism that could be used to decrease waste-intensive convenience lifestyles.

The results of this study found that the CSA group consumers are more engaged in food provisioning routines and behaviors, which may result in reduced food waste. Compared to the other groups, the statistical analysis for the CSA consumers showed more than twice as many correlations between food provisioning routines and demographics, although a few of these correlations may indicate higher levels of food waste. Specifically, these are correlations that show a positive relationship with money spent both on groceries per month and on non-grocery foods, which relates to the findings of Parizeau (2015).

Several correlations were found between demographics and food provisioning routines that differentiate the CSA group from the other groups. The frequency of grocery shopping per month had a weak positive relationship with consumers shopping on their own and cooking themselves. The number of cooking days per week also indicated positive correlations with consumers shopping on their own and cooking themselves. These relationships denote that consumers in the CSA group may be more intensely involved in food provisioning, which again could lead to lower food wastage rates. This could arise from higher awareness and understanding of date labels, refraining from excessive shopping habits, be more disciplined to plan meals, consciously oversee available food in the household, and be better skilled at cooking the right meal portions to avoid leftovers (Lyndhurst et al., 2007; Parizeau, 2015; Quested, 2013; Quested et al., 2013).

Relationships were found between food waste behavior variables (specifically: perceived effort to reduce food waste, frequency of purchasing buy-one-get-one-free promotions, losing track of foods in the refrigerator, and perceived effort to plan meals before grocery shopping) and the following factors that indicate less wasteful behavior in the CSA group: a) cooking days per week and b) consumers cooking themselves. These findings are congruent with literature in the field that pointed out these factors as the main reasons for increased food waste (Evans, 2012; Hartmire et al., 2016; Parizeau, 2015; Quested and Johnson, 2012; Lyndhurst, 2007). Therefore, it is noteworthy that more involved cooking routines in the CSA group show a positive relationship with these behaviors.

Linear regression models developed for food provisioning variables were similar between groups. Significant models for money spent both on grocery shopping and non-grocery foods per month were found in each group, where household income and size showed significant impacts on increasing the amount of money spent on food by consumers. The findings might indicate a sign of profligacy leading to food waste, while it is unsurprising that household income and size were found to have an impact on food purchasing behaviors. It can be speculated that the individuals with higher income levels do not place a high value on food and thus do not pay attention to food waste efforts themselves or the amount of food they waste. This finding was also documented by Baker et al. (2009) and Sustainable Victoria (2010) who stated that higher income households tended to waste large amounts of food. Parizeau (2015) stipulated that households spending large amounts of money on grocery and non-grocery foods may produce higher levels of food waste as a result of over-purchasing, whether from grocery stores or when eating out. Furthermore, larger households have also been shown in the literature to produce more food waste, albeit with less food waste per capita (Baker et al., 2009; Jörissen et al., 2015; Koivupuro et al., 2012; Lyndhurst et al., 2007; Parizeau et al., 2015; Quested et al., 2013; Quested and Johnson, 2012). It seems plausible that larger households spending more money on food may overpurchase it causing confusion among the household members regarding the purchase day, perishability, etc., which, in the end may lead to higher food waste volumes. Thus, the results confirm that regardless of the proximity to food source, higher levels of income and money spent on food, along with larger households, are correlated with higher levels of food waste.

Models developed for food waste behavior variables were largely insignificant with low R^2 values, and thus will not be discussed in detail here. Those models analyzed cooking behavior, the frequency of losing track of foods in the refrigerator, perceived efforts to plan meals, and guilt of wasting food. While these relationships are weak they highlight the need for future research. The lack of significant regression models for those variables is not surprising due to the general complexity of behaviors exhibited by consumers as also confirmed by Evans (2011, 2012) and Quested et al. (2013).

3.6 Conclusion

This study has shown that consumers who are very closely connected to food production (CSA members) have slightly better food provisioning knowledge, are more involved in food provisioning routines, and thus may generate less food waste. Surprisingly, consumers in the farmers' market group show similar behaviors as conventional and specialty grocery store groups. One reason for this outcome may be due to the approach used to sort the data to separate the respective groups for the study. Major behavioral differences in terms of food waste and food provisioning were apparent when comparing the CSA group and the other groups. Differences in food provisioning routines among the groups provided the most indicative proof that proximity to food production has a positive impact on consumers' relationships with food.

Despite the revealed differences between the CSA group and the other groups many similarities were found as well. Food provisioning routines, and specifically cooking routines, and their impact on food waste seem to show the greatest potential for further research. It is straightforward that moving consumers to become more involved in their food provisioning and increasing their knowledge about food may contain part of the solution to food waste. The CSA members represent exactly this pattern. Furthermore, the CSA consumers also exhibit behaviors indicating lower food waste generation, while making a conscious and concerted effort to reduce their food waste. While it is unlikely that all consumers would be interested in participating in CSA groups or similar food provisioning associations, creating more localized food systems may partly contribute to this goal, and ultimately to creating a more sustainable food system.

Further research is needed to address food waste generation subject to consumers' proximity to food source and places of food purchase. While the second aspect was recognized as relevant to mention in this context, it was not considered in this study due to the methodological limitations and survey design. Also, the results of this study could have benefited from investigating exact amounts of food waste generated by the consumers in each analyzed group. Although the surveyed consumers were inquired about their food waste amounts, their responses should be understood as estimates only as most respondents either greatly underestimate the amount of food they waste or they are not able to provide quantitative estimates (which might also vary from day to day subject to cooking habits).

The approach used in this study to divide consumers/ survey respondents into four different groups (according to which each consumer might have been placed in the data set representing either only one group, a couple of groups or each of the groups - depending on their shopping habits) shall be mentioned as a factor generating consumer overlaps in this study. In a perfect world, consumers would have shopped at only one food supply chain and so they could have been completely separated as study samples. However, reality dictates that consumers provision their food from numerous types of food supply chains, and thus cannot

be strictly separated to represent solely one study group. Larger sample sizes would be desirable for a robustness check of the results, which was however hindered by the timeline and scope of this research project as well as available resources to reach the consumers in the respective groups, particularly the CSA members. Lastly, the sample of consumers in the study represents only a small number of consumers in the Oklahoma City metro, which is why the results should not be extrapolated for the entire population in the state of Oklahoma.

Chapter 4: Food Waste Indicator for Dining Halls - A Study for University of Oklahoma

Abstract

Dining halls on university campuses typically generate large amounts of food waste. Most studies in this area have focused on conducting food waste audits or understanding student food waste behavior. However, a standardized approach of analyzing food waste in university dining halls and comparing them across campuses and regions is still missing.

This study proposes a new indicator to measure the potential for food waste creation in university dining halls – the Dining Hall Food Waste Indicator (DHFWI), which was developed based on survey data at the University of Oklahoma. DHFWI is based on six sub-indicators consisting of important behaviors identified from the literature that likely increase the chances for food waste creation. The indicator allows determining the level of potential food waste ranging from low to high (0-1).

The results show a moderate to low potential (mean = 0.34) for food waste creation on the OU campus. Furthermore, the sub-indicator analysis revealed important targets to reduce food waste in OU dining halls. Changes to food serving sizes, targeting student knowledge about food waste, and modifying student meal plan structures (allowing meal points to carry over between weeks and academic school years) indicate the largest effect on food waste reduction.

DHFWI could be used as a means to measure the possibility of food waste generation in situations when time and resources do not allow for conducting food waste audits. Moreover, this indicator is based on a straightforward methodological procedure, and thus it can be applied in different settings and adapted to specific research questions.

4.1 Introduction

Colleges and universities have slowly started to prioritize the use of waste hierarchies in recent years due to the large amount of waste they create and the associated costs of that waste. According to Saphire (1998), higher education institutions in the United States generate approximately 3.6 million tons of solid waste each year, which is around 2 percent of the country's solid waste stream. Dealing with such large amounts of waste creates unnecessary costs, mainly from transporting waste and municipal "tipping" fees required to dispose of waste, for universities. In addition to the economic incentives that universities have to reduce their total waste output they occupy a unique institutional position in society that enables them to engrain knowledge and values into students centered on "ways of living and doing business that conserve resources and prevent waste" with the ultimate goal of nurturing "the environmental stewards of the future" who actualize sustainability in their daily lives (Saphire, 1998). Within universities, food service operations provide 6.5 percent of the total meals eaten away from home in the United States and account for 10 to 20 percent of the total university waste output, which consists of food and food related items (Saphire, 1998; Span, 2012). Nationally, food waste made up 14.6 percent of total municipal solid waste generation in 2013, second only to paper at 27 percent (EPA, 2016). In addition to the clear economic and environmental benefits from reducing food waste, from saved waste management costs, conserved natural resources, and prevented environmental degradation, focusing waste prevention efforts on university food service operations serves as

a model for students of sustainable practices and helps increase awareness of environmental issues on campus (Saphire, 1998). As such, food service operations have the potential to drastically improve the institutional sustainability of any university.

The United States Environmental Protection Agency (EPA) initiated its Food Recovery Challenge in 2013 as part of their Sustainable Materials Management Program to inspire efforts towards preventing or diverting organizational food waste generation. The program is open to any organization so long as they pledge to improve their sustainable food management practices and commit to five actions: 1) sign up; 2) conduct a food waste audit and set a baseline level of food waste; 3) set a reduction goal (tons/year) and identify necessary actions; 4) take actions with identified reduction activities; 5) track progress by reporting food waste prevention results and establish new goals each year (EPA, 2013). National and regional winners are awarded each year for various organizational sectors. The initiative is seen as one of the primary ways the national goal of reducing food waste by 50 percent by 2030 will be accomplished. Indeed, the Food Recovery Challenge has seen substantial reductions in food waste generation. In 2015 alone the EPA claims that 691,000 tons of food waste was diverted from entering landfills or being incinerated, which included 1,000 tons from source reduction prevention activities, 302,000 tons from food donation, 75,000 tons from anaerobic digestion, and 313,000 tons from aerobic composting (EPA, 2013). For comparison, the United States created 233.1 billion pounds of food waste in 2012 (Toth & Dou, 2016). 691,000 tons is equivalent to only 1.38 billion pounds. While the Food Recovery Challenge is a laudable and necessary initiative it may not be sufficient. Furthermore, over half of the food waste they claim to have diverted was used in anaerobic digestion and composting. It must be stated that although both anaerobic digestion and composting provide useful products in the form of methane and/or soil amendments, they do nothing to reduce the generation of food waste and the loss of natural resources and environmental degradation embedded in food waste.

There are currently 976 registered participants in the Food Recovery Challenge, which includes 128 registered colleges and universities across the United States (EPA, 2013). Food waste has become important within universities as evidenced by the growth in published internal food waste audits, composting and anaerobic digestion initiatives, and source reduction initiatives that largely center on the removal of trays from campus dining halls. However, 128 out of a total of 4,147 degree granting postsecondary institutions in the United States is miniscule (National Center for Education Statistics [NCES], 2017). Clearly this is not an indication of all food waste reduction activities at all colleges and universities, as there are most likely many schools that perform some food waste related actions and choose not to participate or may be uninformed that the Food Recovery Challenge exists. Participation in the Food Recovery Challenge is not a panacea but is useful as an indicator of the seriousness with which food waste is given in postsecondary institutions. Whether participating or not higher education institutions have an imperative to concentrate efforts on food waste reduction due to the sustainability consciousness that so many schools claim to advocate and the long-term impact that sustainability education can have on the developing minds of university students.

4.2 Literature Review

4.2.1 Dining Hall Food Waste Audits

The largest majority of published studies in the literature on university campus food waste focus on dining hall waste audits. Food waste audits are essentially meant to provide quantification of current levels of food waste in single dining halls or multiple dining halls on the same university campus. Determining a baseline level of food waste is a crucial starting point for setting reduction goals and then creating feasible methods for achieving those goals. A clear distinction within this literature subsection exists between studies seeking to quantify pre-consumer food waste, post-consumer food waste, or both. Pre-consumer food waste, or prep kitchen waste, is waste that is a by-product of food preparation in dining hall food services (Span, 2012). There are numerous types of food waste that can be classified as pre-consumer: kitchen trimmings that are unavoidable but can sometimes be used in additional recipes; recoverable food that has been cooked but not served; and serving station or buffet remains that are often considered non-recoverable (Cirone, Crouch, Kim, & Konneh, 2016). The primary causes of pre-consumer food waste are from poor demand management that can cause overproduction, poor inventory management, fluctuation in sales, and mental lapses from employees (Span, 2012; Whitehair, Shanklin, & Brannon, 2013). People eating in dining halls who choose not to finish the food they take produce post-consumer food waste, or plate waste. Post-consumer food waste is, thus, the result of behavioral choices on behalf of dining hall customers, usually students (Bailey, Boxberger, Gambucci, & Peters, 2015; Lazell, 2016; Lorenz, Hartmann, & Langen, 2017; Painter, Thondhlana, & Kua, 2016).

A larger number of studies in the literature conducted food waste audits to determine post-consumer food waste levels in various university dining halls. The majority of these studies are conducted at universities in the United States with only a few looking at universities in other nations. The audit by Merrow, Penzien, and Dubats (2012) compared plate waste between cook-to-order and buffet style dining at Western Michigan University. All-you-can-eat buffet style dining halls are thought to produce large amounts of pre-consumer and post-consumer food waste (Costello, Birisci, & McGarvey, 2016; Merrow et al., 2012; Lam, 2010; Saphire, 1998; Span, 2012; Thiagajarah & Getty, 2013). This is due to the nature of all-you-can-eat buffets in that there is no marginal cost to consumers for taking additional food and no marginal revenues for additional items sold, which entices consumers to continually take more food and food services to over-produce (Costello et al., 2015). Surprisingly, Merrow et al. (2012) found that plate waste in the buffet style dining hall was only 0.58 ounces more per student than the cook-to-order plate waste.

Several studies examine both pre- and post-consumer food waste (Burcham, Saba, Sing, 2011; Cirone et al., 2016; Costello et al., 2015). Each of these studies highlights the disparity between consumer food waste as a result of student behavior and kitchen pre-consumer food waste. In each case plate waste produced by students was nearly twice the amount produced pre-consumer. Burcham et al. (2011) found that students eating dinner at one University of Virginia dining hall produced 104.2 pounds of plate waste (1.56 ounces/person) compared to 40.5 pounds of pre-consumer kitchen waste. Cirone et al. (2016) tried to characterize different food waste streams from a single buffet dining hall at the University of Pennsylvania over ten days in terms of pre-consumer food waste (unavoidable kitchen trimmings, recoverable food that has been cooked but not served, non-recoverable service station remains) and post-consumer plate waste. The pre-consumer waste streams averaged

between 7 and 17 pounds each day, while daily plate waste averaged 138 pounds (76 percent of total food waste). They draw attention to the success that kitchen staff at this dining hall have had in forecasting demand, keeping track of inventory, and planning meals, which has clearly had an impact and kept waste to a minimum. However, the focus must shift to reduction and prevention efforts that target consumers and the factors affecting their food habits and behaviors that lead to such large amounts of plate waste (Cirone et al., 2016). A much longer study over three months by Costello et al. (2015) that quantified pre- and post-consumer food waste from four dining halls at the University of Missouri also estimated the embodied greenhouse gas emissions generated. Of the 232.4 tons of food served 13.9 tons were lost as pre-consumer waste that emitted 11.1 tons CO_2 equivalent, while nearly twice as much plate waste was produced that amounted to 26.4 tons with 56.1 tons of embodied CO_2 equivalent emissions.

4.2.2 Source Reduction and Prevention

University food services have traditionally centered their operations on all-you-can-eat buffet style dining halls with reusable trays (Saphire, 1998). Buffet style operations produce large amounts of both pre- and post-consumer food waste, which makes up 60-75 percent of the total waste produced in these facilities (Saphire, 1998). In response to the large amounts of food waste produced in all-you-can-eat dining halls, Aramark, a large university food service provider, introduced trayless dining as a simple solution to post-consumer plate waste. Aramark (2008) found that food waste could be reduced by 25-30 percent through eliminating the use of trays in a study that covered 186,000 meals in 25 higher education institutions across the United States. The reasoning behind switching to trayless dining is that "with trays, patrons can take more food than they need and either discard the excess as waste or overeat. The trayless system limits the amount of food taken at a time, theoretically increasing the likelihood that patrons will take only what they will eat (Thiagajarah & Getty, 2013, p. 6). Aramark (2008) claim that trayless dining is a true "triple-bottom-line" sustainability solution in that it decreases an institution's environmental footprint (less waste produced, less energy and water needed to clean trays, and less detergent and drying agent use that pollutes water supplies), saves money (less waste removal and less resource use), and improves social awareness of environmental issues on campus. Numerous studies support the claim that trayless dining has marked impacts on levels of food waste in dining halls. Reductions in food waste amounts of 10.8 percent (Karstens & Moe, 2009), 18.5 percent (Thiagajarah & Getty, 2013), 32 percent (Kim & Morowski, 2012), 54 percent (Kim & Freedman, 2010), and 0.8 ounces/person/meal (Getty, Thiagajarah, & Fowler, 2011) have been observed in various studies. Sarjahani, Serrano, and Johnson (2009) found that using trays resulted in 5,829 pounds and 1,111 pounds of edible and inedible food waste, respectively, more per week than when trays were removed from a university all-you-can-eat buffet. Thapa, Ingerson, and Lewis (2016) estimated that removal of trays in a buffet style dining hall would prevent 107,143 pounds of food waste and 18,849 gallons of water per semester. A study by Babich and Smith (2010) quantified food waste shortly after switching to a trayless system and determined that food waste from each student was a miniscule 1.04 ounces/day.

In addition to implementing trayless dining, targeted reduction campaigns in dining halls have been tested to gain insight into the most successful food waste prevention mechanisms. These have centered exclusively on either providing educational information to students (Kim & Freedman, 2010), using social media and/or message based information (Lazell,

2016; Smith, 2015), or a combination of both (Ellison, Nehrling, Nikolaus, & Duff, 2017; Luecke, 2015; Whitehair et al., 2013) to alter food waste behaviors. Kim and Freedman (2010) was the first study to combine educational information on plate waste to students in dining halls with a trayless intervention. Their initial educational effort decreased student plate waste by 25 percent from a pre-intervention baseline measurement of 7.7 ounces/person/meal, while the additional trayless implementation led to a 54 percent reduction from the baseline. Twitter was used to allow students at a university in West Midlands, United Kingdom to send messages to other students informing them of available food that a specific individual may not finish in Lazell (2016). Students in the study perceived the social media tool positively although it failed to alter food waste behavior mainly due to unfamiliarity between students and a lack of trust. Smith (2015) piloted a community-based social marketing tool in which signs targeting social norms and prompts to throw away food in a compost bin or to avoid wasting food altogether were posted directly adjacent to disposal areas. Post-intervention measurements revealed that 94 percent of food that would normally be disposed in the trash was successfully diverted. Post-consumer plate waste was sorted and weighed during lunch over a 13 week period in an all-you-can-eat dining hall with an educational campaign introduced during week eight that focused on economic, environmental, and social aspects of food waste and gave individual diners feedback on their personal waste amounts (Ellison et al., 2017). With insignificant effects the authors emphasized that educational campaigns may be insufficient alone and should be accompanied by changes in dining environments such as pricing strategy, menu size, and increases in pre-plated food items. In a similar study, Whitehair et al. (2013) tracked individual plate waste and used two types of messages in consecutive interventions that each lasted two weeks. The first intervention was a prompt-type message reminding students to not waste food and the second provided feedback based on personal food waste amounts. Additional educational posters were stationed around the dining hall. A 15 percent reduction in post-consumer plate waste was observed after the prompt-type message but no additional reductions resulted from the second. Luecke (2015) surveyed students to determine food waste knowledge, attitudes, and behaviors and then distributed educational text messages based on themes identified from the survey, although no significant change was observed in post-intervention plate waste.

Two studies analyzed how portion size impacts food waste in university dining halls. Freedman and Brochado (2010) looked specifically at whether decreasing portion sizes of french fries in a mostly freshman dining hall would decrease consumption and plate waste and found a positive correlation between the variables. Wansink and Van Ittersum (2013) hypothesized that the size of dinnerware serves as a visual anchor when people determine appropriate fill levels. After an experiment with 219 university students they found that people generally fill plates 70 percent full no matter the plate size. Consequently, reducing the size of plates available in dining halls would decrease food waste and the costs associated with food preparation and waste management.

Lastly, tracking technology used for forecasting demand, food inventory needs, and recipe adjustments can be a powerful tool to reduce pre-consumer food waste in foodservice operations. The need for tracking technology stems from the fact that “inaccurate forecasting results in over-production or under-production” (Ryu, Jang, & Sanchez, 2003). Under-production of food is seen as unacceptable in foodservice operations largely because of the low cost, convenience oriented, and consumer driven focus of the food system (Span, 2012). As a result of this, over-production that leads to food waste is commonplace in dining halls, especially buffets, and so utilizing “tracking methods may make a significant impact on the

forecasting, purchasing, and preparation decisions of foodservice managers" that ultimately results in much greater efficiency and reduced food waste (Span, 2012, p. 36). More specifically, Ryu et al. (2003) demonstrated that using seasonally adjusted data is 85 percent more accurate than raw data and produced much more accurate forecasts for foodservice managers, which is crucial for the seasonal operation patterns of university dining halls. Moreover, a national survey revealed that foodservice administrators believed that accurate forecasting in computer programs that modify food production practices was the second most significant strategy after educating customers for reducing dining hall food waste (Kwon et al., 2010).

4.2.3 Student Food Waste Behavior

Understanding student behaviors that contribute to large amounts of post-consumer plate waste in university dining halls is perhaps the most important issue in reducing dining hall food waste. However, consumer behaviors that result in food waste are complex and *"can be attributed to an amalgamation of routines and habits with behavior determined by the prevailing nature of practices (in dining halls) and the associated behavioral norms in this space"* (Lazell, 2016, p. 439). Essentially, students who eat in dining halls bring with them their own personal attitudes, norms, intentions, knowledge, and perceived behavioral control, yet their behavior is also greatly impacted and shaped by the normal practices and culture in specific university dining halls (Lorenz et al., 2017). Furthermore, contextual factors, mainly time constraints, also play a major role in contributing to wasteful behaviors (Lazell, 2016; Painter et al., 2016). Individual behaviors such as serving too large a portion for oneself, number of times students return for additional servings, personal preferences related to perceived food quality that includes appearance, taste, smell, texture, and temperature, and low food waste awareness that requires educational efforts have been identified as major contributors to post-consumer plate waste (Alooh, 2015; Bailey et al., 2016; Burcham et al., 2011; Cirone et al., 2016; Kwon et al., 2010; Lam, 2010; Lazell, 2016; Lee, 2015; Lorenz et al., 2017; Merrow et al., 2012; Painter et al., 2016; Whitehair et al., 2013). Interestingly, two studies found that females wasted significantly more food in dining halls than males (Lorenz et al., 2017; Painter et al., 2016).

Institutional factors, or the practices and norms that exist in specific dining halls, that have been shown to negatively impact student food waste behaviors are related to being served too much, plate and/or bowl size, using trays, and lack of menu options (Aramark, 2008; Bailey et al., 2016; Burcham et al., 2011; Cirone et al., 2016; Ellison et al., 2017; Freedman & Brochado, 2010; Getty et al., 2011; Karstens & Moe, 2009; Kim & Freedman, 2010; Kim & Morowski, 2012; Kwon et al., 2010; Lam, 2010; Lazell, 2016; Lee, 2015; Lorenz et al., 2017; Merrow et al., 2012; Painter et al., 2016; Saphire, 1998; Sarjahani, Serrano, & Johnson, 2009; Thapa et al., 2016; Thiagajarah & Getty, 2013; Wansink & Van Ittersum, 2013; Whitehair et al., 2013). Two studies found that the lack of self-serve ability (Bailey et al., 2016; Painter et al., 2016) increased the chances of food being wasted, while another study concluded that self-serve ability would increase the amount of food taken and ultimately the amount of food wasted (Lorenz et al., 2017). Converting buffets into a la carte serving styles with pre-plated entrees is an important institutional factor that can improve wasteful behaviors (Ellison et al., 2017; Lam, 2010; Merrow et al., 2012; Saphire, 1998). Furthermore, due to the wide variety of options often available in university dining halls students may be curious about trying specific dishes that they end up rejecting due to personal standards (Bailey et al., 2016). Thus, foodservices should consider providing samples to students as a preventative measure

(Merrow et al., 2012). Lastly, pricing strategies (Costello et al., 2015; Ellison et al., 2017) and payment systems (Bailey et al., 2016) may contribute to student food waste behavior.

4.3 Research Objective

University dining halls generate significant amounts of food waste. Such large amounts of waste create unnecessary economic, environmental, and social burdens on universities and the communities they are a part of. As a result of this there is a clear imperative for universities to reduce their food waste levels and improve their overall sustainability. For this to happen, however, universities need an in-depth knowledge and understanding of the food waste behaviors of students, their potential for waste creation, and their willingness to alter behaviors and habits.

As such, the major goals of this paper are twofold: 1) to create an indicator that measures the potential for food waste creation of individual people or groups of people in dining hall settings and 2) pinpoint possible areas and measures that could be taken to reduce food waste in OU dining halls.

Based upon the literature review, there have been no previous studies attempting to develop a quantitative measure (i.e., indicator) of food waste creation at university dining halls. The indicator developed herein is a novel approach within this field of study. It can be used as a measure of potential food waste creation when time and resources do not allow researchers to conduct food waste audits. Furthermore, this indicator is a simple approach that can be applied in a number of settings and adapted to specific needs. It is not meant to be a universal instrument to understand food waste and can certainly be improved and expanded with more comprehensive equations.

4.4 Methodology and Data

Anonymous online surveys using Qualtrics software were sent by email to the University of Oklahoma student body in April and May of 2018. The main target group of students at the university was those who regularly eat at the major student dining hall on campus, Couch Restaurants. Questions asked to students focused on food choices, satisfaction and complaints about the foods available, food waste habits and behaviors, opinions on how the Housing and Food department could improve the dining hall food waste situation, and demographics. The University of Oklahoma has a student population of approximately 32,000. The total number of surveys completed and utilized in the data analysis was 253, for a response rate of 0.7 percent. However, a more accurate response rate would include only the number of students who eat at Couch Restaurants, which is likely a small percentage of total university students and would likely increase the response rate. This number could not be determined.

After a comprehensive review of the literature on campus dining hall food waste six behaviors were identified as the most important in terms of their potential for food waste creation. Each of these six concepts was used as questions within the survey and then as sub-indices of a composite indicator called the Dining Hall Food Waste Indicator (DHFWI). For the indicator, the questions given within the survey were structured as one to five scales, where a response of one corresponds to low potential for food waste creation and five

corresponds to high potential for food waste creation. The questions making up the sub-indices were:

A) How many full plates of food do you normally take?
B) How often do you take more food than you can eat?
C) How much effort do you make to monitor your portion sizes?
D) What portion of food on your plate do you normally leave unfinished?
E) How aware are you of the impact that food waste can have on the environment and society?
F) How likely would higher food prices cause you to reduce the amount of food you leave unfinished when eating there

Creation of the indicator followed concepts from Mazziotta and Pareto (2013), Talukder, Hipel, and vanLoon (2017), OECD "Handbook on Constructing Composite Indicators" (2008), and UNDP "Training Material for Producing National Human Development Reports" (2015). In the most simplified manner composite indicators typically follow several steps: 1) defining what is to be measured; 2) selecting sub-indicators; 3) normalization of the sub-indicators; and 4) aggregation of the sub-indicators into one index value (Mazziotta & Pareto, 2013). The DHFWI does not follow one specific index method due to the fact that "no universal method exists for composite indices construction. In each case their construction is much determined by the particular application" (Mazziotta & Pareto, 2013, p. 71). The indicator most closely followed here is the Human Development Index, which uses a minimum-maximum transformation for normalization and a geometric mean for aggregation. However, where the DHFWI deviates is in the aggregation step. The DHFWI uses equal weights for the sub-indices and so takes a simple arithmetic mean. Furthermore, the structure of the sub-index questions (scale of 1-5) results in some index values of zero when aggregated using a geometric mean, particularly when answers of "1" were given. This remains true even if all other answers given are "5". By using the arithmetic mean the only possibility of a DHFWI value of "0" corresponds to when all sub-index responses are "1". The opposite is observed when all sub-index responses are "5", which results in a DHFWI value of 1.

For the purposes of this study the normalization method used for sub-index responses is a minimum-maximum transformation that is defined with equation 1:

$$Equation\ 1) = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}$$

After normalization of the sub-index values they were further aggregated together into the final DHFWI value using the arithmetic mean that is defined with equation 2:

$$Equation\ 2) = \ A = \frac{1}{n} * \sum_{i=1}^{n} x_i$$

$$A = arithmetic\ mean$$
$$n = number\ of\ terms$$
$$x_i = \ value\ of\ individual\ terms$$

The aggregation results in the final index value ranging from zero to one. As index values approach zero they represent the potential for very low food waste creation. The opposite is true also, where values approaching one represent the potential for very high food waste

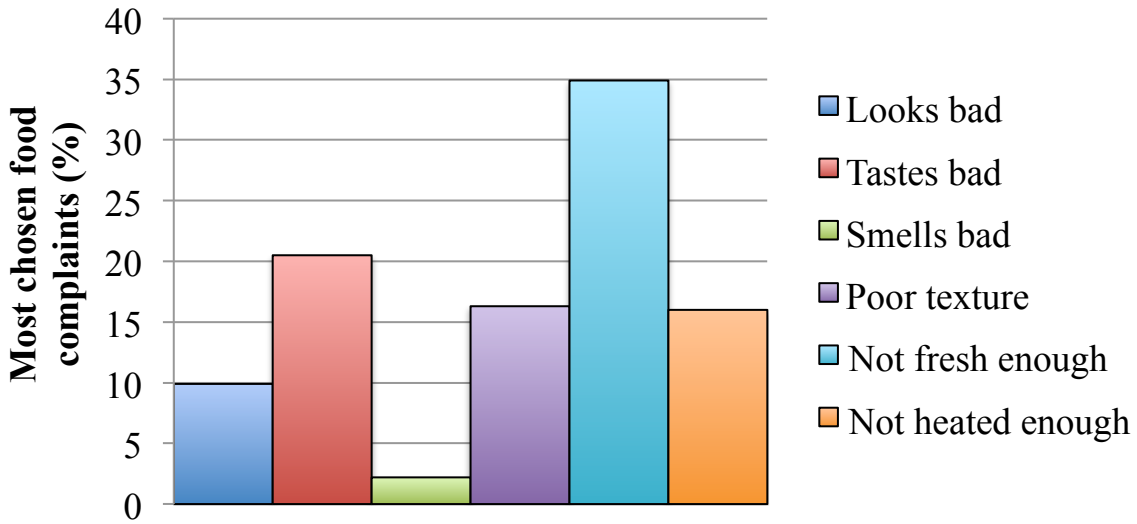
creation. Again, index values of zero and one are both possible if all responses are given as "1" or "5" for an individual person, respectively.
As the major goals of this paper were to 1) develop the DHFWI and 2) identify possible approaches for food waste reduction in OU dining halls, the data were ultimately also used to describe the current food waste situation at Couch Restaurants as indicated by the survey outcomes.

4.5 Results

Students were asked general questions regarding food and waste habits when eating at Couch Restaurants. The most chosen types of food that students eat (~75% of the time) are full meals (30.3%), special offer meal of the day (19%), pizza/other prepared foods (17.9%), salads (15.8%), sandwiches (9.4%), and hamburgers/fries (7.3%). Do students enjoy the foods they are eating at Couch Restaurants? Complaints about the food quality were numerous. The most chosen food quality complaints were "not fresh enough" (34.9%), "tastes bad" (20.5%), "poor texture" (16.3%), "not heated enough" (16%), "looks bad" (9.9%), and smells bad (2.2%) (fig. 4).

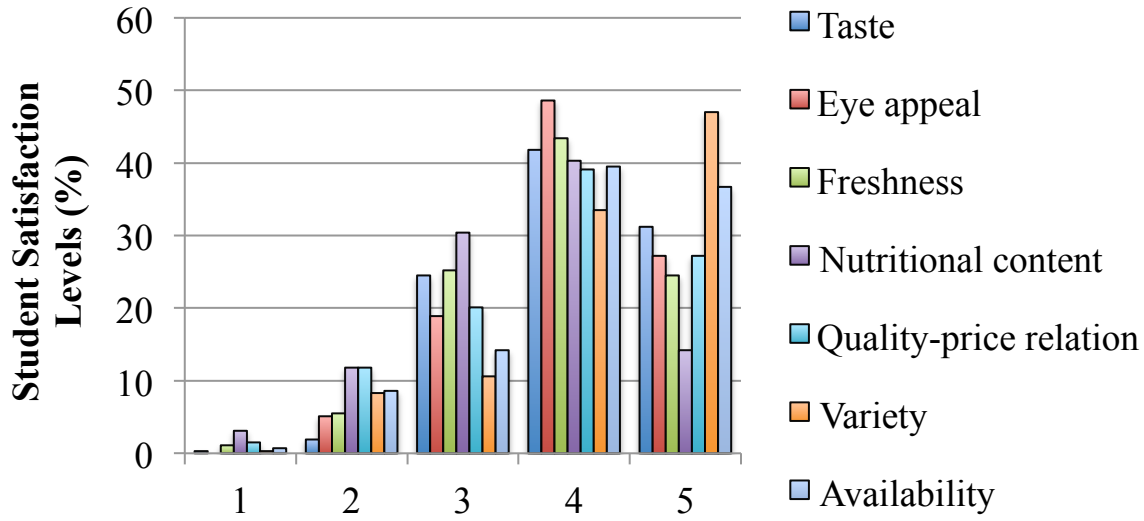
Next, students were asked what types of food they waste the most with results fairly uniform among food types. Surprisingly, deserts were the most wasted food type (20.1%), followed by fruit/vegetables (19.1%), grains (18.4%), meats (17.4%), sweetened drinks (15.2%), dairy (4.9%), and eggs (4.6%). It is crucially important to understand why these foods are being wasted so that those in charge can target specific areas within Couch Restaurants. When asked what the main reasons for leaving unfinished foods on plates are, students chose "took too much food" and "bad taste/smell/look" the most frequently, at 29.8% and 29.3%, respectively. Following these were "was served too much" (16.3%), "wasn't hungry" (12.4%), and "no time to finish everything" (11.9%).

Figure 4 – Complaints on food quality in Couch Restaurants



Seven survey questions were asked to gain an understanding of student satisfaction for a variety of dining hall food characteristics. Each question was structured with a five point Likert-style scale, where a response of one corresponds with "very dissatisfied" and a response of five corresponds with "very satisfied". The food characteristics targeted with these questions were taste, eye appeal, freshness, nutritional content, quality-price relation, variety, and availability. Overall, responses indicate moderate to high levels of satisfaction among students, which are found in Figure 5.

Figure 5 – Satisfaction of food characteristics in Couch Restaurants



The next set of questions related to student perceptions of how well the University of Oklahoma Department of Housing and Food was already doing to prevent food waste, opinions on how the Department of Housing and Food could prevent future food waste, and what educational measures the Department of Housing and Food could implement that would be most impactful in helping students reduce their food waste. Results for the first question were very split between two responses: 41.2% of respondents believed that the Department of Housing and Food was not doing enough already to prevent food waste, while 46.4% were not sure. Only 8.3% of respondents believed they were already doing enough to prevent food waste, while 3.9% responded that they did not care. The results of the question asking students what the Department of Housing and Food could do to reduce food waste are shown in Figure 6. The most chosen solution was "providing students with educational material on food waste" at 20%, but it is evident students believe very uniformly that a wide number of potential solutions would help minimize food waste creation in the dining hall. Lastly, on which types of educational material would be the most effective in helping students reduce their food waste, "posters with information on food waste around the dining hall" was chosen as the most helpful at 33.2%. Following this most closely was "screens with information on food waste around the dining hall" (20.5%) and "individual assessments of your personal food waste" (20.1%). Results are shown in Figure 7.

As stated in the methods section, six questions were used as sub-indicators for the DHFWI. Descriptive statistics describing the sub-indicator questions are found in Table 8, while Figure 8 displays boxplots of each central tendency and interquartile range. Five out of six sub-indicators (A – E) had means that were less than or equal to 2.6, while the same five also

had modes of three or less. Sub-indicator F was the only sub-index with an interquartile range greater than three.

Figure 6 – Opinions on how to reduce food waste at Couch Restaurants

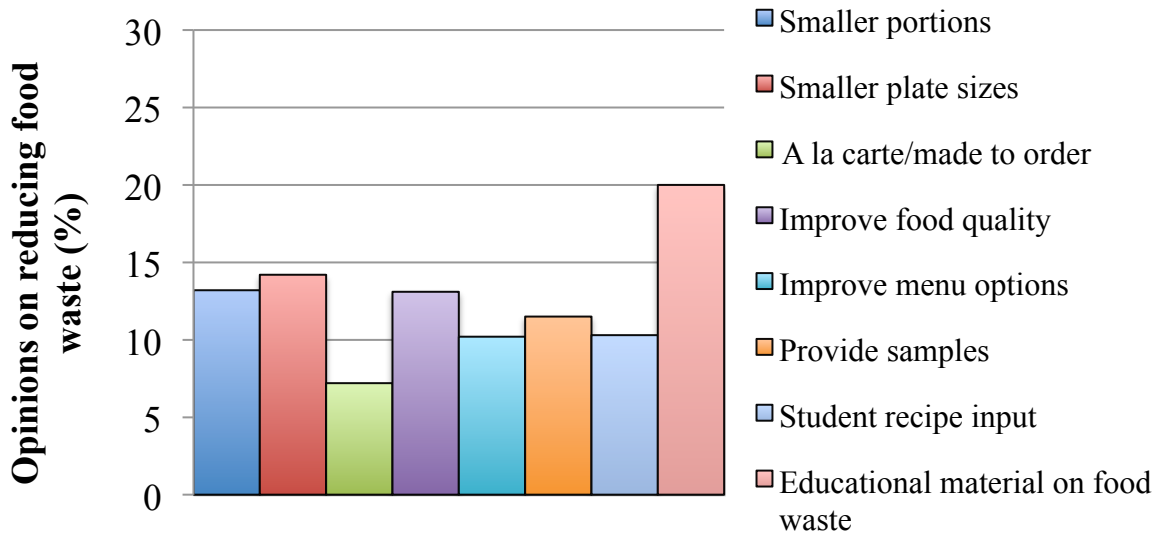


Figure 7 – Opinions on the most effective educational measures to reduce food waste

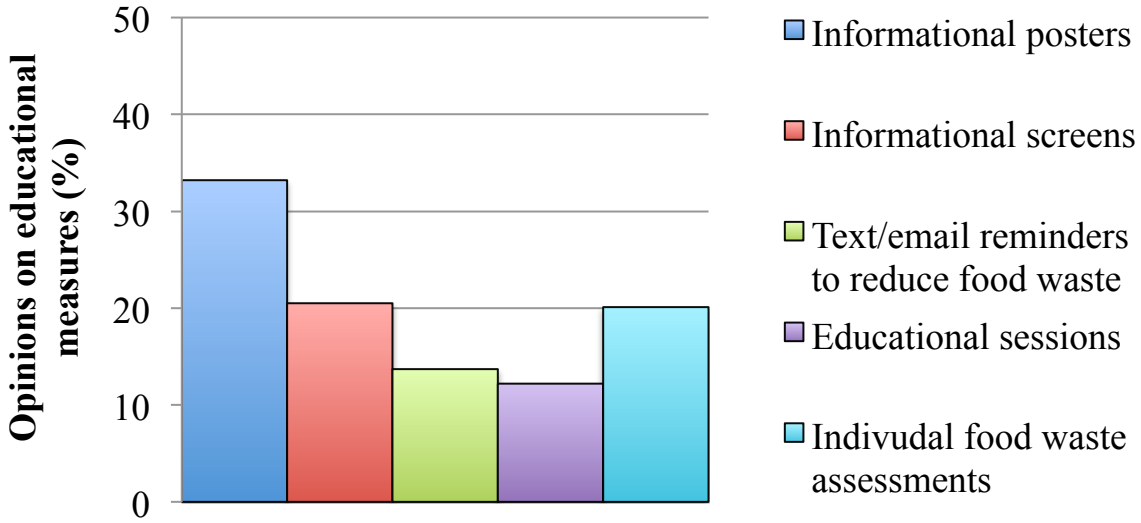
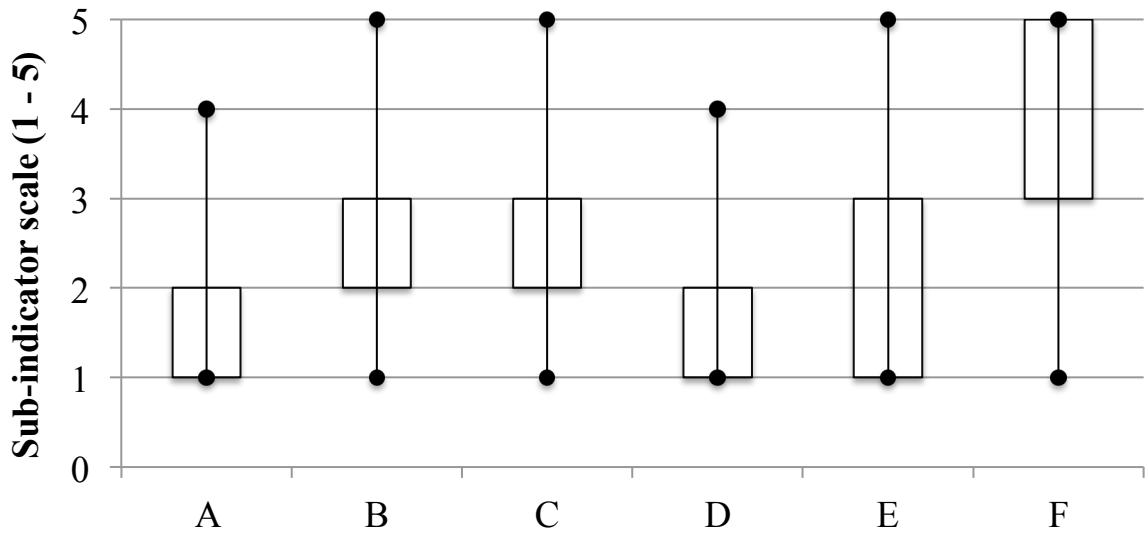


Table 8 – Descriptive statistics for sub-indicators and DHFWI

	Mean	Median	Mode	Standard Deviation	Quartile 1	Quartile 3	IQR
A	1.73	2	2	0.72	1	2	1
B	2.5	2	2	0.93	2	3	1
C	2.6	3	3	1.01	2	3	1
D	1.54	1	1	0.61	1	2	1
E	2.15	2	1	1.09	1	3	2
F	3.86	5	5	1.4	3	5	2
DHFWI	0.34	0.37	0.41	0.12	0.25	0.41	0.16

Note: A: "How many full plates of food do you normally take?". B: "How often do you take more food than you can eat?". C: "How much effort do you make to monitor your portion sizes?". D: "What portion of food on your plate do you normally leave unfinished?". E: "How aware are you of the impact that food waste can have on the environment and society?". F: "How likely would higher food prices cause you to reduce the amount of food you leave unfinished when eating there?"

Figure 8 – Box plots representing sub-indicator central tendencies and interquartile ranges



Note: A: "How many full plates of food do you normally take?". B: "How often do you take more food than you can eat?". C: "How much effort do you make to monitor your portion sizes". D: "What portion of food on your plate do you normally leave unfinished?". E: "How aware are you of the impact that food waste can have on the environment and society?". F: "How likely would higher food prices cause you to reduce the amount of food you leave unfinished when eating there?"

Descriptive statistics for the DHFWI are found in Table 8 along with the descriptive statistics for each sub-indicator. After calculation, 18 different index values were generated across the total sample size and reveal a standard distribution, which is shown in Figure 9. The mean, median, and mode of the index values were 0.34, 0.37, and 0.41, respectively, with a minimum calculated value of zero and a maximum of 0.75. Figure 10 shows a boxplot of the

central tendency and interquartile range for the DHFWI. Over 62% of the index values fell within the first two quartiles, while only 14.2% fell within the third quartile. The interquartile range fell between 0.25 and 0.41, with 35.1% of index values falling in the second quartile. Data were also separated into demographic groups to compare DHFWI values. Descriptive statistics for these are found in table 9. These results indicate that, among those surveyed here, the majority of students dining at Couch Restaurants on the University of Oklahoma campus, even when split into separate demographic groups, have moderate to low potential for food waste creation based on the DHFWI values.

Figure 9 – Distribution of DHFWI values

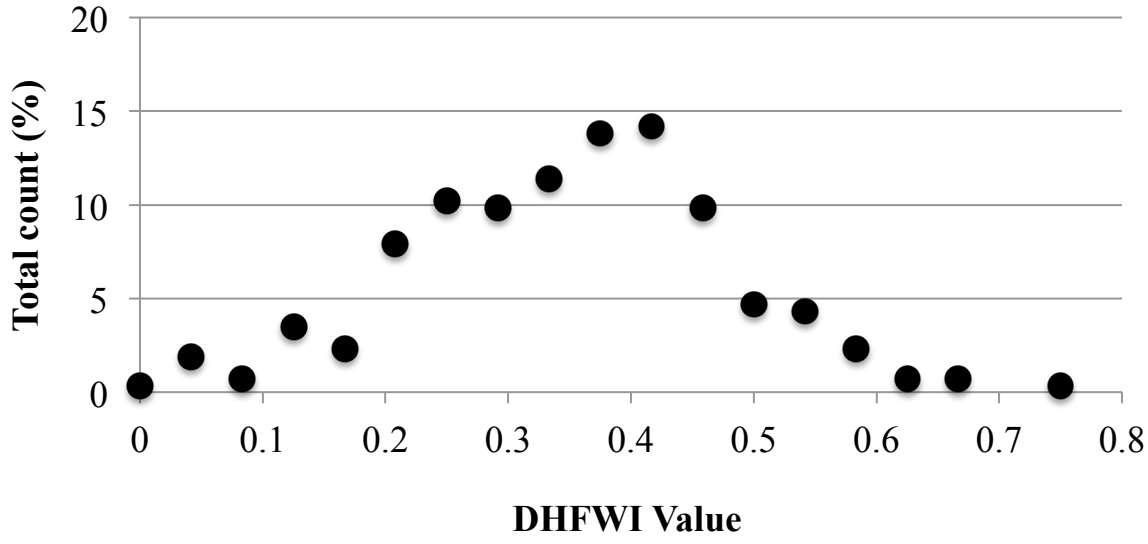


Figure 10 – Boxplot representing DHFWI central tendency and interquartile range

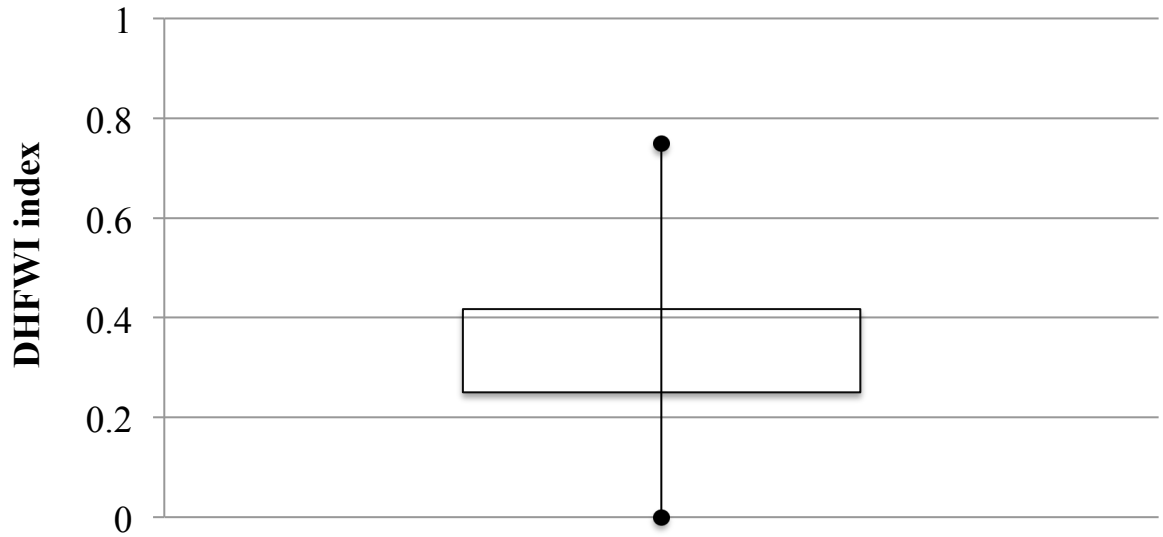


Table 9 – DHFWI descriptive statistics separated by demographic characteristics

Demographic Type		Mean	Median	Mode	SD	Quartile 1	Quartile 3	IQR
Gender	Male	0.36	0.37	0.45	0.14	0.29	0.45	0.16
	Female	0.34	0.33	0.41	0.11	0.25	0.41	0.16
Grade Level	Undergraduate	0.35	0.37	0.41	0.12	0.29	0.41	0.12
	Graduate	0.29	0.29	0.37	0.15	0.16	0.37	0.20
Hours Studying Per Week	< 10	0.37	0.37	0.41	0.12	0.29	0.43	0.14
	10 – 20	0.36	0.37	0.37	0.12	0.29	0.43	0.14
	20 – 30	0.34	0.33	0.33	0.14	0.25	0.41	0.16
	30 – 40	0.31	0.33	0.33	0.11	0.25	0.41	0.16
	> 40	0.33	0.33	0.29	0.12	0.25	0.41	0.16
Housing Type	Student Dorm	0.35	0.37	0.41	0.11	0.25	0.41	0.16
	Rented House	0.33	0.35	0.37	0.15	0.25	0.41	0.16
	Rented Room	0.34	0.33	0.33	0.12	0.29	0.41	0.12
	My Own House	0.25	0.20	0.20	0.19	0.14	0.30	0.15
	My Parents' House	0.34	0.35	n/a	0.16	0.22	0.46	0.23

4.6 Discussion

The results of this study provide interesting context for future studies and for improving the sustainability outlook of Couch Restaurants at the University of Oklahoma. While the DHFWI values depict moderate to low levels of food waste among student diners at Couch Restaurants, many improvements could potentially still be implemented. Furthermore, the development of the DHFWI provides a simple index for future research to better understand the potential for food waste in college dining halls and in situations when resources are limited or not available to conduct a full food waste audit.

Students taking part in this study chose desserts as the most wasted type of food, which contradicts most studies in the literature. However, other categories of food waste chosen by students confirms much of what has been found regarding fruit/vegetable and meat waste, which generally ranges from 20 to 30 percent of food supply losses (Buzby & Hyman, 2012; Gustavsson et al., 2011; Toth & Dou, 2016). Student food waste behaviors, as stipulated by the students themselves here, confirm findings from other studies regarding individual behaviors that increase food waste, such as serving oneself too much food, being served too much food and not objecting to this, and personal preferences to perceived food quality (Bailey et al., 2016; Burcham et al., 2011; Lazell, 2016; Lorenz et al., 2017). Interestingly, students were overall very satisfied with a number of food characteristics within Couch Restaurants, which contradicts their choice that poor food characteristics was one of the major reasons why they waste food.

Although the DHFWI values suggest moderate to low levels of food waste potential for those surveyed, a significant number of students (41.2%) did not believe that the Department of Housing and Food was doing enough to prevent food waste at Couch Restaurants. This suggests that students are perceptive to how much food is actually wasted there and that there may be significant amounts of food waste generated by students. Removal of trays from

university dining halls has been identified numerous times as one of the highest impact changes dining halls can make to reduce food waste (Aramark, 2008; Thiagajarah & Getty, 2013; Kim & Morowski, 2012; Sarjahani, Serrano, & Johnson, 2009). Further, converting buffet-style dining to a la carte or made to order has had similar impacts on reducing food waste (Costello, Birisci, & McGarvey, 2016; Merrow et al., 2012; Lam, 2010; Saphire, 1998; Span, 2012; Thiagajarah & Getty, 2013). It is important to note that the Department of Housing and Food has already implemented both of these strategies. Students may simply be unaware of this and so believe those in charge have done little to reduce food waste.

In addition to both of these measures, however, students believed a wide number of initiatives would help reduce food waste at Couch Restaurants, with providing educational material to students on food waste as the most popular choice. Educational campaigns to reduce food waste have had mixed success among studies (Ellison et al., 2017; Kim & Freedman, 2010; Luecke, 2015; Whitehair et al., 2013). Other popular choices among students in this study such as smaller portion sizes, smaller plate sizes, and providing samples to students have been shown to help minimize dining hall food waste (Freedman & Brochado, 2010; Merrow et al., 2012; Wansink & Van Ittersum, 2013). What has become clear within this study from the wide number of measures students believe would be beneficial in reducing food waste, and what confirms the findings of Ellison et al. (2017), is that food waste reduction campaigns must target both changes in dining hall environments and specific types of educational measures at the same time.

Although the DHFWI values generated portray the general survey population dining at Couch Restaurants to have moderate to low potential for food waste creation, each sub-indicator could be targeted in different ways to reduce the potential for food waste. The sub-indicators that the results show would be most impactful in helping to reduce the potential for food waste creation due to their moderate to high means are sub-indicators B ("how often do you take more food than you can eat?"), C ("how much effort do you make to monitor your portion sizes?"), and F ("how likely would higher food prices cause you to reduce the amount of food you leave unfinished when eating there?"). The literature on dining hall food waste stresses that low food waste awareness is a major cause for food being wasted. As a result, addressing sub-indicators B and C, with means of 2.5 and 2.6, respectively, should be straightforward. Whitehair (2013) found that "simply making students aware" and "reminding them to act on their beliefs" regarding food waste might be effective for positively altering behaviors (p. 68). Both of these sub-indicators provide a platform for making changes to the dining hall environment (by making portion sizes uniformly smaller) and implementing educational campaigns to make the food waste issue within the dining hall more visible. Sub-indicator F is a much more difficult concept to implement into action, as over 50% of those surveyed indicated that higher food prices in the dining hall would not at all cause them to reduce the amount of food they waste. However, it is clear in the literature that pricing strategies and payment systems are a major contributor to dining hall food waste (Bailey et al., 2016; Costello et al., 2015; Ellison et al., 2017). It is possible that the majority of those surveyed pay for meal plans through the University of Oklahoma. As a result, students may be less impacted by price changes. However, the manner in which meal plans are structured at the University of Oklahoma is such that points do not carry over between weeks or between academic school years (Spring to Fall semester). According to Costello et al. (2015), meal plan systems acting in such a manner promote taking excess food due to a lack of marginal costs. As such, alterations to the meal plan system that adds greater flexibility for students may be a necessary change if reducing food waste is an important goal of the Department of Housing and Food.

4.7 Conclusion

This study has sought to better understand food waste behaviors of students in the main dining hall at the University of Oklahoma, Couch Restaurants. This was accomplished in two ways. First, the creation of a Dining Hall Food Waste Indicator (DHFWI) was designed to take certain kinds of knowledge, behaviors, and thought processes found in the literature to be major causes of food waste creation, and combine them into an index number between zero and one. The major benefit of the method used within this paper lies in its simplicity and the ease at which it can be transferred and modified for use in other studies of the same nature, particularly when researchers have limited time and/or resources.

Second, the survey used as the basis of this study sought to understand what foods students were wasting the most, why they were wasting foods, their satisfaction with numerous food characteristics, and their opinions on how those in charge of the major dining hall on campus could reduce the amount of food being wasted. This information could potentially be helpful to further improve the food waste situation on campus and make the University of Oklahoma a more environmentally sustainable institution in this area.

A weakness of the study, and the DHFWI, is that it does not directly measure the amount of food waste created. Time and resources limited the authors' ability to conduct a food waste audit at the dining hall. Further research using the DHFWI could combine it with a waste audit component and incorporate this into the index methodology. Moreover, the methodology, while simple, could be further refined to incorporate more components and use more robust mathematical equations. The DHFWI followed a standardized method for constructing a composite index. As such, the index provides a basis from which further research on dining hall food waste and food waste in general, can expand from. Additionally, it is likely that food waste creation differs by season in dining halls. Further research might target this issue, particularly during different ends of a semester.

Chapter 5: Conclusions of the research

Chapter 2 put into context the damaging nature of food waste towards broader goals of food system sustainably. The economic, environmental, and social costs of food waste can be severe. Many of the environmental and economic costs stem from the production phase of agriculture, which itself can be a very resource and capital intensive human activity that can produce large impacts on the environment. Costs can increase and accumulate as a food product travels further downstream the food supply chain towards the point where it is most often wasted, mainly at the consumer level. The social aspects of food waste are also most evident at the consumer level. Although food wasted in high-income nations would likely never reach consumers in other parts of the world who suffer from food insecurity, the food that an individual chooses to waste could rather be used to help those who need it in their local area. It also has an opportunity cost by theoretically reducing the resources available to produce food for those who need it or apply those resources for other purposes.

Despite the apparent impacts that food waste can have when it occurs at consumer level the issue is given very little visibility or importance by consumers in high-income nations. It is evident in both studies within this thesis that consumers often do not perceive the action of wasting food as problematic. In Chapter 3, the consumers participating in the study widely shared the belief that they wasted very small amounts of food, while identifying food waste as "moderately harmful" for the environment and society. The consumers participating in the survey depicted in Chapter 4 widely responded that they often leave unfinished food on their plates and only make moderate efforts to monitor their portion sizes, despite the widely shared belief among them that food waste is an important issue and can have large impacts on the environment and society. Whether the underlying causes of food waste are from an excessive surplus of food supply or from a disconnection between consumers and food production, both of which have been widely debated in the food waste literature and discussed within this thesis, consumer food waste has increased over time and there have been no studies showing that it is abating.

Food waste will never disappear entirely for several reasons. First, all food is perishable. Second, there will always be inedible parts of food that turn into food waste. Furthermore, the societies need some amount of food waste to create beneficial products that help to alleviate the negative impacts of agriculture, such as compost and other soil amendments. Some food waste is also used in animal husbandry, which can help alleviate the need for food crops being used as feed crops. However, the 1.3 billion tons of food waste occurring each year globally (Gustavsson et al., 2011) is generally not used for such purposes and typically is left to decompose producing CH_4, a greenhouse gas 21-25 times more powerful than CO_2.

Negligent consumer behaviors resulting in food waste both at home and away from home are perhaps the most important reasons why food is wasted. Although some consumers in both studies showed knowledge about food waste and put forth conscious efforts to reduce their food waste creation, the majority of the study participants did not exhibit knowledge or behaviors that are significantly different from the prevalent characteristics of consumers identified in other studies resulting in the high levels of food waste so often measured. This is likely due to the complex and sometimes confusing aspects of human behavior that occurs in everyday life. It is the complexity of consumer food waste behavior and the difficulty in altering aspects of individual behaviors that makes reducing consumer food waste a difficult task to accomplish. In the context of this difficulty and the need to reduce food waste more broadly due to its damaging impacts chapters 3 and 4 of this thesis provided insights into specific food waste behaviors, their complexity, and potential solutions to add knowledge to the discussion currently taking place in this field.

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Appendix A: Chapter 3 Survey – Does Proximity to Food Source Impact Food Waste Behavior

1) How many times per month do you go grocery shopping?

2) How much money on average do you spend on grocery shopping each month?

3) How much money on average do you spend on non-grocery food each month? (e.g. eating out, prepared foods, etc.)

4) What percentage of your food comes from the following (total should sum to 100%):
   - Supermarkets/large grocery stores
   - Specialty grocery stores (e.g. Sprouts, Natural Grocers, Whole Foods)
   - Farmers' markets/farm stands
   - Community supported agriculture (CSA)
   - Other, specify

5) Who in your household is doing most of the grocery shopping for you?
   - Myself
   - My partner
   - My parents
   - My roommate
   - Other, specify

6) Does anyone in your household follow a special diet? Please check all that apply:
   - Vegan
   - Vegetarian
   - Paleo
   - Mediterranean
   - Other, specify

7) On average, how many days each week do you cook meals from scratch? (not including pre-prepared, all-in-one box meals)

8) Who in your household is preparing most of the food you eat?
   - Myself
   - My partner
   - My parents
   - My roommates
   - Other, specify

9) What percentage of the food you purchase do you throw away?

10) What are the reasons that you throw away food?
   - Moldy
   - Bad taste/smell/look
   - Went past its sell-by or expiration date
   - Cooked too much/don't like leftovers
   - Ended up ruining what I was cooking
   - Incorrect storage

- Other, specify

11) What kinds of uneaten foods do you throw away the most?
- Fruit/vegetables
- Dairy products
- Meat/seafood
- Prepared foods (cooked meals)
- Liquid drinks
- Grains (e.g. rice, flour, corn, oats, etc.)
- Eggs
- Nuts
- Fats and oils
- Other, specify

12) How willing are you to eat food past its sell-by or expiration date?
- Not at all willing
- Slightly willing
- Moderately willing
- Very willing
- Extremely willing

13) When you throw away food do you feel guilty, frustrated, embarrassed, annoyed, or regretful about throwing it away?
- Don't have any regrets
- Slight regrets
- Moderate regrets
- Strong regrets
- Very strong regrets

14) Do you make an effort to minimize the amount of food you throw away?
- No effort
- Slight effort
- Moderate effort
- Strong effort
- Very strong effort

15) How often do you purchase "buy one get one free" or similar type promotions at the grocery store?
- Never
- Rarely
- Sometimes
- Often
- Always

16) How often do you stockpile fresh food (i.e. not dry, boxed goods) when you go grocery shopping (i.e. buying more than you might actually consume)?
- Never
- Rarely
- Sometimes
- Often

- Always

17) How often do you lose track of foods you have in your refrigerator or pantry after grocery shopping that end up being wasted?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Always

18) How much effort do you make to plan meals, estimate the amount of food needed, and make shopping lists before grocery shopping?
    - No effort at all
    - Slight effort
    - Moderate effort
    - Strong effort
    - Very strong effort

19) Do you make an effort to eat foods that are in season (e.g. tomatoes in summer, squashes in fall, asparagus in spring, etc.)?
    - No effort at all
    - Slight effort
    - Moderate effort
    - Strong effort
    - Very strong effort

20) How important is it to you to purchase/eat locally grown foods?
    - Not at all important
    - Slightly important
    - Moderately important
    - Very important
    - Extremely important

21) Would you be willing to pay more for locally grown fruits and vegetables?
    - Yes
    - No

22) What would be the maximum additional charge per pound you would be willing to pay for locally produced fruit or vegetable foods?

23) Would you be willing to pay more for locally produced, free range/pasture-raised meat?
    - Yes
    - No

24) What would be the maximum additional charge per pound you would be willing to pay for locally produced, free range/pasture-raised meat?

25) How important is it to you to know the person who grew your food?
- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important

26) How important is it to you to purchase/eat organically produced foods?
- Not at all important
- Slightly important
- Moderately important
- Very important
- Extremely important

27) Do you grow your own fruit or vegetables in a garden at home?
- Yes
- No

28) Do you compost your uneaten food and food scraps?
- Yes
- No

29) Would you be willing to pay an additional amount each month for curbside compost pickup?
- Yes
- No

30) What would be the maximum additional charge per month you would be willing to pay for curbside compost pickup?

31) How harmful do you think food waste is on the environment and on our natural resources?
- Not at all harmful
- Slightly harmful
- Moderately harmful
- Very harmful
- Extremely harmful

32) Would you be interested in learning about ways to reduce your household food waste?
- Not at all interested
- Slightly interested
- Moderately interested
- Very interested
- Extremely interested

33) Which of the following would motivate you to reduce food waste?

- Knowing that food waste can harm the environment and contribute to climate change
- Knowing that almost 1 billion people on earth don't have adequate access to food
- Knowing that you waste hundreds of dollars every year because of food waste in your household
- None of those, food waste doesn't bother me
- Other, specify

34) What is the highest level of education you have completed?

- No schooling completed
- Some high school, no diploma
- High school graduate, diploma, or equivalent
- Some college credit, no degree
- Associate degree
- Bachelor's degree
- Master's degree
- Professional degree
- Doctorate Degree
- Other, specify

35) What is your gender?

- Female
- Male
- Other

36) What is your age?

37) What is/was your occupation?

38) What is your annual household income?

- Below $20,000
- Between $20,000 and $40,000
- Between $40,000 and $60,000
- Between $60,000 and $80,000
- Above $80,000

39) How many people live in your household?

40) How many adults live in your household?

41) Which category best describes you?
- White
- Hispanic
- Black or African American
- Asian
- American Indian or Alaskan native
- Middle Eastern or North African
- Native Hawaiian or other Pacific Islander
- Some other race, ethnicity, or origin

Appendix B: Chapter 4 Survey - Food Waste Indicator for Dining Halls - A Study for University of Oklahoma

1) 1. How many days per week do you eat at the Couch dining hall on campus?

2) On the days you eat at the Couch dining hall, how many meals per day do you usually purchase there?

3) What kind of food do you buy most (~75% of the time)? (check all that apply)
- Salads
- Sandwiches
- Pizza and/or other prepared foods
- Hamburgers and French fries
- Full meal (protein, carbs, veggies)
- Special offer meal of the day
- Other, specify

4) When you eat at the Couch dining hall, which of the following serving styles do you choose your food from the most (~75% of the time)?
- Buffet style
- A la carte style
- Made-to-order style
- Other, specify

5) How satisfied are you with the taste of the food?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

6) How satisfied are you with the eye appeal of the food?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

7) How satisfied are you with the freshness of the food served?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

8) How satisfied are you with the nutritional content of the food served?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied

- Very dissatisfied

9) How satisfied are you with the quality – price relation of the food?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

10) How satisfied are you with the variety of the food?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

11) How satisfied are you with the availability of the food served there that you prefer to eat?
- Very satisfied
- Somewhat satisfied
- Mixed feelings
- Somewhat dissatisfied
- Very dissatisfied

12) If you have complaints about the food quality, what about the food do you not like? (Check all that apply)
- Looks bad
- Tastes bad
- Smells bad
- Poor texture
- Not fresh enough
- Not heated enough
- Other, specify

13) How many full plates of food do you normally take?
- 1
- 2
- 3
- 4
- 5

14) How often do you take more food than you can eat?
- Never
- Rarely
- Sometimes
- Often
- Always

15) How do you feel about the portion sizes served to you?
- Way too small
- Slightly too small
- Perfect amount
- Slightly too large
- Way too large

16) How much effort do you make to not overload your portion sizes when serving yourself?
- Very strong effort
- Strong effort
- Moderate effort
- Weak effort
- No effort at all

17) What portion of food on your plate do you normally leave unfinished?
- None
- ¼
- ½
- ¾
- Full plate

18) What types of food do you leave unfinished the most when eating? (check all that apply)
- Fruit/vegetables
- Meat
- Grains
- Dairy products
- Eggs
- Desserts
- Sweetened drinks
- Other, specify

19) What are the main reasons you leave unfinished food on your plate? (check all that apply)
- Bad taste/smell/look
- Wasn't hungry
- No time to finish everything
- Took too much food
- Was served too much food
- Other, specify

20) At which meal during the day when eating at the Couch dining hall do you have the most leftovers or leave the most unfinished food on your plate?
- Breakfast
- Lunch
- Dinner
- I'm not wasting any food

21) How aware are you of the impact that food waste can have on the environment and society?
    - Very strongly aware
    - Strongly aware
    - Moderately aware
    - Slightly aware
    - Not at all aware

22) How likely would higher food prices cause you to reduce the amount of food you leave unfinished when eating there?
    - Very strongly likely
    - Strongly likely
    - Moderately likely
    - Slightly likely
    - Not at all likely

23) When you throw away food do you feel guilty, frustrated, embarrassed, annoyed, or regretful about throwing it away?
    - No regrets at all
    - Slight regrets
    - Moderate regrets
    - Strong regrets
    - Very strong regrets

24) What would you personally do to greatly reduce your food waste? Please specify:

25) Do you believe OU Housing and Food is already doing enough to prevent food waste?
    - Yes
    - No
    - I don't care
    - I'm not sure

26) What do you think OU Housing and Food could do to greatly reduce food waste? (check all that apply)
    - Smaller portions
    - Smaller plate sizes
    - Serving everything as a la carte or made-to-order
    - Improving the food quality
    - Improving the menu options
    - Providing samples of each food choice
    - Incorporating student input into certain recipes
    - Providing educational material on food waste to students
    - Other, specify

27) What educational measures do you think OU Housing and Food could establish that would be the most effective in reducing dining hall food waste? (Check all that apply)
    - Posters with information on food waste around the dining hall
    - Screens with information on food waste around the dining hall
    - Monthly or weekly reminders to not waste food in email, text message, or campus newspaper
    - Periodic educational sessions on food waste for student diners
    - Individualized assessments on your personal food waste
    - Other, specify

28) Who do you believe is responsible for the majority of food waste in society?
    - Producers (farmers)
    - Food processors
    - Transport
    - Retail (grocery stores, restaurants, food service companies)
    - Consumers

29) What is your age?

30) What is your gender?
    - Male
    - Female
    - Other

31) What degree are you currently pursuing?
    - Bachelor
    - Master
    - PhD
    - Professional degree
    - Certificate program
    - Other, specify

32) What department are you currently enrolled in?

33) What is the highest degree obtained by your father?
    - High school diploma
    - Vocational
    - Bachelor
    - Master
    - PhD
    - No degree
    - Other, specify

34) What is the highest degree obtained by your mother?
- High school diploma
- Vocational
- Bachelor
- Master
- PhD
- No degree
- Other, specify

35) What is your nationality?

36) How much time are you devoting to work or studying?
- < 10 hours per week
- 10 – 20 hours per week
- 20 – 30 hours per week
- 30 – 40 hours per week
- > 40 hours per week

37) Please choose one of the following – I am currently living in:
- A student dorm
- A rented house
- A rented room
- My own house
- My parents' house
- Other, specify