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Reducing greenhouse gases through food waste reduction: a literature review of programs and behavior change

Schafer Flowerday
University of Nebraska Medical Center

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Reducing greenhouse gases through food waste reduction: a literature review of programs and behavior change

Schafer Flowerday

Master's Program of Public Health: Environmental and Occupational Health

Committee Chair: Dr. Eleanor Rogan

Committee Member: Willa DiCostanzo

Committee Member: Dr. Kristina Kintziger

ABSTRACT

Anthropogenic greenhouse gas (GHG) emissions significantly contribute to climate change. Methane is a potent GHG emitted in landfills as organic material breaks down. Food waste is the single most common item disposed of in Lincoln's Bluff Road Landfill (LTU, 2022). As such, food waste disposal in the landfill is a preventable issue that could dramatically reduce GHG emissions in Lincoln. This project seeks to determine what barriers and motivations exist for reducing food waste at a consumer level. A literature review was conducted to find what behavior change campaigns and interventions have taken place nationwide to encourage residential food waste reduction. Behavior change can be influenced by the motivation to reduce waste, access to the tools and infrastructure that promote less waste, and the skills and knowledge required to perform less food-wasting behaviors. While few peer-reviewed studies on reducing food waste have been conducted, a selection of studies show that social norms, commitments, and education are all community-based social marketing strategies that can reduce food waste. The best interventions will utilize multiple strategies at once.

CHAPTER 1: INTRODUCTION

Problem statement:

How communities dispose of their waste is responsible for a large amount of greenhouse gas emissions. Landfills containing municipal solid waste, or household trash, are the third highest sector producer of methane (EPA, 2023). Methane is a more potent greenhouse gas than carbon dioxide (EPA, 2023). Increased concentrations of greenhouse gases in the atmosphere create poor air quality and lead to climate change. Methane in landfills is caused by organic material decomposing without oxygen (EPA, 2023). While gases emitted from the landfill are collected, this system still has fugitive emissions. An overall reduction of the methane produced is one way to mitigate climate change impacts. Thus, encouraging residents to waste less food will, in turn, reduce the amount of organic material entering Bluff Road Landfill, leading to a lower contribution to climate change.

Landfills also take up valuable land to provide a safe place to dispose of waste. Even with a more expansive land area than some parts of the country, building a new landfill requires lots of money. It will cost around $10 million to prep the following parcel of land to receive garbage once the current landfill is full. Reducing the volume of waste sent to the Bluff Road Landfill will prolong its lifetime, thus the importance of educating the public on Lincoln's recycling program.

Purpose:

This project aims to review the literature on how other municipalities have encouraged food waste reduction in their communities. This will explore the benefits and barriers to increased waste prevention and diversion. Synthesizing this information into one report will provide a social marketing firm, working with the City of Lincoln, with data to craft messages to deliver to the target populations identified.

Research Questions:

- What barriers to food waste reduction may exist in Lincoln, NE?

- What motivators would encourage residents to reduce wasted food?

CHAPTER 2: BACKGROUND

Lincoln, Nebraska, has a unique waste management system. It comprises 15 private waste-hauling companies in an open-market system (City of Lincoln, 2024). Open-market systems for waste mean that a household can choose which provider they want. The household will also pay a monthly subscription fee for waste collection. All waste collected in Lincoln and Lancaster County is transported to the Bluff Road Landfill (City of Lincoln, 2024). The City of Lincoln runs the Bluff Road Landfill through the Transportation and Utilities Solid Waste Management division.

In 2018, the Lincoln Municipal Code was changed to mandate that clean corrugated cardboard is banned from the Bluff Road Landfill, and each hauler must offer curbside recycling services to all customers. A household must opt-in and pay a monthly fee to access curbside recycling. Before 2018, only two companies offered curbside recycling in Lincoln and Lancaster County. In addition to curbside recycling, the City of Lincoln operates several large consumer recyclables collection sites around the city. These are available at no direct cost to the public. Still, they are supported via indirect costs collected through the waste produced and disposed of in Lancaster County, collected through the occupation tax described above. These recyclable collection sites are the only locations where glass can be recycled. Haulers choose not to collect glass in single-stream, curbside recycling due to the contamination it causes and its dangerous nature when broken. Single-stream recycling is when highly recyclable materials such as plastic containers, tin, aluminum, office paper, newspaper, paperboard, and cardboard are placed in one bin or comingle. Historically, recycling used to be source-separated, meaning you would have to collect all paper in one bin, tin in another, aluminum, etc. As recycling has advanced, so has the technology to separate the recyclable materials in mass volume. With this advancement, the efficiency and volume of recyclable materials collected have advanced.

Once collected, recyclables go to a Material Recovery Facility (MRF). The MRF sorts the materials using a combination of employee manual sorting, conveyor belts with separation technology, robotics, computer identification, and magnetic separation (First Star Fiber, 2024). Once the recyclable materials have been separated, they are baled, sold, and distributed around the country to be remade into new products.

If recyclable materials are not collected through the recycling process, they will be placed into a landfill with the rest of the rest of the waste produced. Contrary to how waste is managed in other countries or states, waste is managed at the Bluff Road Landfill with safety in mind; thus, it is not sorted at the landfill for ultimate reuse. That separation scale is unmanageable, with nearly 800 tons of waste entering the facility daily. Landfills are highly engineered facilities to comply with federal and state permits and regulations (City of Lincoln, 2024). Landfills keep the public safe by providing space to dispose of all municipal solid waste (MSW) or household trash. They keep the surrounding environment safe by lining the bottom and sides of the landfill with liners that

keep leachate, the liquid that has come in contact with the trash in the landfill, from entering the soil or groundwater. The groundwater is monitored regularly to ensure no contamination of leachate or MSW. A landfill gas system is another component of some landfills, including Bluff Road. This is a series of pipes that run vertically and horizontally through each phase of the landfill. These pipes act as a vacuum to collect the gases emitted within the landfill. Once collected, the gas is cleaned and either burned off into carbon dioxide (CO_2) instead of entering the atmosphere as methane or cleaned and sent to the power station as renewable natural gas (RNG). Landfill gas (LFG) is comprised of about 50/50 carbon dioxide and methane, with a small amount of other volatile organic compounds (VOCs) (EPA, 2023).

In the United States, MSW landfills accounted for 14.4% of the total methane emissions in 2022 (EPA, 2023). This is the third-largest source of methane in the United States (EPA, 2023). Methane is a greenhouse gas which is linked to climate change. Methane has a more significant warming potential than carbon dioxide at 27-30 times the effect on the atmosphere as carbon dioxide (EPA, 2023). This means that while it has a shorter lifetime in the atmosphere than CO_2, it also has a much higher ability to trap energy. Methane is created in landfills as organic materials decompose anaerobically or without oxygen. These organic materials include food, tree waste, cardboard, and paper. According to the 2022 waste characterization study, 40% of the waste entering Bluff Road is organics, and 16% is paper. This means that organic material makes up over half of what is disposed of in landfills.   These numbers demonstrate the significance of this issue and how much of this organic waste could be either prevented or disposed of more beneficially.

In 2023, the EPA developed an updated version of its Food Waste Hierarchy. They recognized the importance of reducing the amount of food and organics we are sending to landfills and sought to understand which options for food disposal had the most significant impacts on the environment. The United States wastes more food per capita than any other country (EPA, 2023). Most of this food ends up in landfills, leading to substantial preventable methane emissions. Not only does food waste contribute to emissions at the disposal stage, but when food is landfilled, it wastes all of the resources put into growing, distributing, transporting, and selling the food. Land, energy, water, fertilizer, and pesticides are required at each stage to grow and process crops.

Studies have also examined which food types lead to the highest greenhouse gas emissions, and most have concluded that meat and dairy products have the highest carbon footprint per weight of food (EPA, 2023).

This review will seek to understand how to change behaviors and encourage the community to do the following:

1. Reduce food from being wasted and sent to the landfill

2. Increase the understanding of resource recovery (e.g., the recycling process in our community, what belongs in the bin, etc.).

The review will seek to identify if there are differences in barriers and motivators between each target population.

Target Populations:

The target population has been broken into three groups. The primary population of this study will be residents within the 14 census tracts in Lincoln identified by the EPA as disadvantaged. These census tracts were identified as disadvantaged if they were "(1) at or above the threshold for one or more environmental, climate, or other burdens, and (2) at or above the threshold for an associated socioeconomic burden (Climate and Economic Justice Screening Tool)". These burden indicators fell under categories: climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. The associated socioeconomic burden that applied to most of these categories in the community was at or above the 65th percentile for low income. The exception to this was the category of 'workforce development.' The related socioeconomic burden for the workforce category was if more than 10% of the census tract had below a high school level education. In Lincoln, waste services are an additional cost, with only one of the 15 haulers offering a curbside composting option. Likely a significant barrier to recycling access, this is part of why it is important to frame this research with lower-income areas in mind. In addition, Lincoln is a hub for new Americans from different cultures and backgrounds who may have differing motivators and barriers from each

other and others in the community. Countries manage waste differently, so educating immigrant families on how our local system works would reduce confusion, a common barrier to recycling.

Figure 1: Map of EPA-identified disadvantaged census tracts
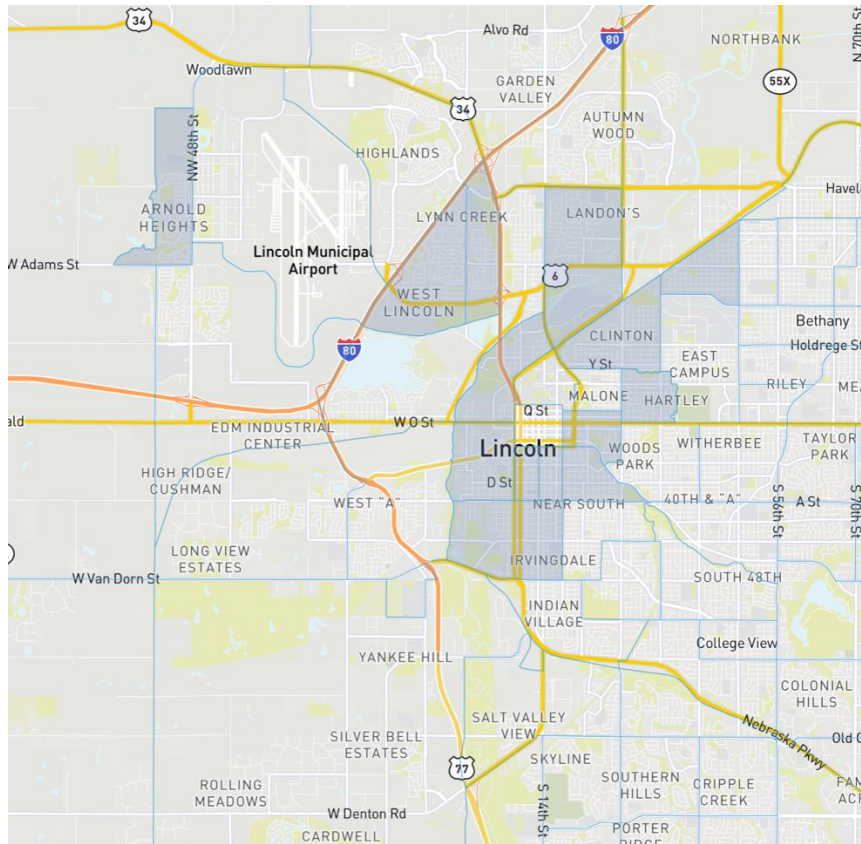
Another target population is students attending the University of Nebraska-Lincoln (UNL). As of Fall 2023, were 23,600 students enrolled at UNL (University of Nebraska System, 2023). Students will have different motivators and barriers to reducing their waste, so it is essential to look at appealing to a younger demographic. Finally, the third target population is the rest of the Lincoln community.

CHAPTER 3: METHODS

This project will primarily look at this issue through the lens of community-based social marketing (CBSM). This idea introduced by Doug McKenzie-Mohr explains research on how psychology intersects with positive

environmental behaviors and how to encourage behavior changes. There are five steps in CBSM: 1. selecting behaviors, 2. identifying barriers and benefits, 3. developing strategies, 4. pilot testing, and 5. broadscale implementation (McKenzie-Mohr, 2012). This project and literature review will focus on the first two steps and make suggestions for the third step. The social marketing firm will give the information to work on messaging. The firm will then be at the forefront of pilot testing their messages within the Lincoln community, tweaking as needed before implementing city-wide.

The results on whether this messaging is effective will be measured through a waste characterization study at the Lincoln Landfill in 2027. Waste characterization studies are conducted at the Bluff Road Landfill every five years. This study collects data on the types and quantities of waste disposed of in the Bluff Road Landfill to track waste trends in the community of Lancaster County. Results from 2022 will be used as a baseline to compare to 2027.

The literature review will use multiple databases. Greenfile, Eric, PsychInfo, JSTOR, and Google Scholar will be searched. Articles will be included in the review if they are from 2010 or later. Studies that use interventions should take place in the United States unless they contain specific messages for different cultures. Search terms will include combinations of community-based social marketing, food waste, waste reduction, campaign, education, toolkit, barriers, benefits, motivators, behavior change, messaging, campaign implementation, and interventions. Qualitative and quantitative data will be accepted. If a relevant article is referenced, that article may also be added to the review.

 In addition, a peer network run through the EPA called Food Too Good to Waste will be consulted. People in this group work all over the country in various capacities to reduce food waste. Many of them may have already conducted research or campaigns that could be valuable to this project. A request will be put out to the group to share any reports or knowledge from their municipalities with me. This stage of the review did not yield any directly helpful results. This is because many of the campaigns explored in the group do not have set measurements to compare a control group or baseline to determine effective strategies. Still, this led to many contacts and social media design toolkits.

Chapter 4: RESULTS

Frameworks

Many reviews of food waste behavior use the Theory of Planned Behavior as a framework (Christopher et al., 2021; Visschers et al., 2016; Graham-Rowe, 2014). The Theory of Planned Behavior states that human social behavior is tied to personal attitudes, subjective norms (what people perceive others to do), and perceived behavioral control (Ajzen, 1991). Essentially, a person with high intention or motivation to behave in a certain way is likelier to perform that behavior. While this is a great start, this framework fails to account for the attitude-behavior gap. The attitude-behavior gap occurs when there is dissonance in peoples' values and intentions and what they act on. When looking at an issue as complex as food waste and the whole food supply chain, it is essential to consider contextual factors and a person's motivation to change their behavior.

Another theoretical framework through which to look at food waste is the Motivation-Opportunity-Ability (MOA) framework (Ölander & Thøgersen, 1995). This has also been used to frame waste research (NASEM, 2020). The MOA framework includes the social and cultural contexts, habits, and their role in behavior change. The MOA framework has been selected for guiding this literature review as it is a more comprehensive approach to investigating the drivers and barriers to food waste reduction. As the name implies, there are three components of this framework:

- Motivations- this aspect describes a person's attitudes and intended behavior related to food waste.
- Opportunities- refers to access to the tools and infrastructure required to make changes to reduce a person's food waste.
- Abilities refers to whether a person possesses the knowledge and skills to change behavior.

Looking at food waste through this framework tells us that food waste is driven not only by the intention to waste food, as is rarely the case but rather by combining many interworking factors. Consumers will default to routine or nonconscious factors when one or more of these components are low (NASEM, 2020). For example, even if someone is highly motivated to reduce their food waste, if they do not have adequate knowledge of food safety or what different 'best-by' dates mean, it will be more difficult for that desire to translate into action. Each of the three components important to food waste reduction will be investigated in depth before looking at the interventions that will be most useful in increasing consumers' motivation, opportunity, and ability to reduce their food waste. It is important to note that food waste can occur at any stage of food management.

Motivations:

As much of the food waste research to date has focused on the Theory of Planned Behavior, which is centered around motivations, there is a good idea of what is driving food waste and what could motivate consumers to reduce their waste. The literature shows that finances are often the top concern for those interested in reducing food waste (Graham-Rowe et al., 2014). Significantly, as food prices rise, consumers see food waste as a waste of money. Messages focusing on average dollars wasted per household or showing how much could be saved may increase motivation to reduce this waste.

It has also been found that ethics can trigger motivation to reduce food waste. People often see food waste as 'bad' or 'wrong,' while reducing waste is doing the 'right' thing to do (Schanes, 2018). This ethical mentality related to wasting food can come from a consumer's background, such as growing up in a time or location where unnecessary waste is less acceptable. This ethical mindset is less often tied to knowledge of the environmental consequences of food waste and a desire to reduce their carbon footprint (Graham-Rowe, 2014; Schanes, 2018). Environmental concerns appear to take a backseat to other motivations. In studies where survey or interview participants are not presented with ecological concerns as a possible motivator, almost no one offers it as an option (Visschers, 2016). That said, those who have a past of engaging in pro-environmental behavior, such as recycling, and who see themselves as valuing the environment are more likely to be motivated to reduce their food waste (Greiger et al., 2019; Schanes, 2018). People who have recycled in the past may also

see themselves as environmentally conscious, leading to continuing the behavior that confirms their self-identity and could also translate that into reducing their other wastes (Geiger et al., 2019). This shows us that targeting a message towards related environmental concerns may not work in a broad population but could be enough to motivate those already environmentally inclined.

Related to ethics, consumers are motivated by their emotions associated with food waste. Consumers have stated feeling negative emotions such as guilt, frustration, and anxiety when actively wasting food (Graham-Rowe, 2014). These negative emotions can stem from some of the above motivations, but they still produce waste due to various contextual reasons, such as opportunities or abilities.

Opportunities-

Opportunities are related to consumers' access to the tools, time, and infrastructure to change their behavior. There are several factors to consider when considering consumers' opportunity to reduce food waste. These can occur on an individual or household level, such as lifestyle and scheduling factors. Households juggle work, social, and potentially school schedules that entail some uncertainty that can change food plans, regardless of intention. Those who feel they have less available time are correlated with creating more food waste (Mallison et al., 2016). Access to tools and technologies provides additional opportunities to drive or reduce food waste. A refrigerator set at the correct temperature for optimal food safety is an example of supporting opportunities to reduce food waste within an individual's home.

On a broader scale, the built environment will affect a household's waste. The types of foods and grocery shops available will differ from area to area and must be considered when looking at food waste (van Herpen et al., 2019). Those living in food deserts or lacking personal transportation are more likely to create food waste due to purchasing larger quantities at once (Geffen, 2020).

Opportunities are also provided on a city or state-wide scale from regulations and policies that may be in effect. Some cities and states around the United States have enacted organics bans in landfills or mandated composting collection, giving an opportunity to reduce food waste going into the landfill in these areas at the disposal stage

for consumers. Whether these opportunities occur on an individual or city scope, they can drive or reduce consumers' waste behaviors at any stage, from planning and acquiring to storage to how they dispose of foods.

<u>Abilities-</u>

Abilities can also be affected at any stage of food management but are specific to an individual. Abilities are based on an individual's possession of the knowledge and skills to perform behaviors. Based on interview results, these abilities are learned through imitation of important people (commonly family), working in restaurants, or self-taught (Graham-Rowe, 2014). Adequate knowledge is pertinent to reducing waste at each consumer stage. Having the skills to take inventory of what already lies in the home, plan meals, and create a list can help reduce waste. Once food arrives home, knowing proper storage techniques for different produce and determining if food has gone bad becomes important. Many consumers do not know what the dates on food packages mean, leading to more food waste from foods that are presumed spoiled before they are (Van Geffen et al., 2020). Various terms are used: sell-by, use-by, best-by, best if used by/before, and expiration. Excluding infant formula, these dates do not indicate food safety and are entirely voluntary on the manufacturer's part (USDA, 2023). If consumers think a sell-by date means the last day food will be 'good,' more food waste will likely occur. At the disposal stage, if a household wants to prevent food waste in the landfill but does not have the opportunity to compost as a weekly service, they will need the knowledge required to start a backyard compost pile.

<u>Barriers to reduction</u>

Whether tied to motivation, opportunity, ability, or a combination, various barriers prevent households from reducing food waste. To make a long-term behavior change, people will need one sustained motivator and initiate change if the effort and cost are low (NASEM, 2020).

The first barrier currently hindering people from reducing the amount of food they throw away is being aware that it is an issue. This lack of awareness can act as a lack of motivation- due to the perceived behavioral control or ability- simply not being aware of the magnitude yet. Education on how wasted food has negative

social, environmental, and economic impacts would be a way to target this barrier. It is important to note that combining it with other intervention techniques will often have a more significant effect than removing this barrier alone (van Herpen, 2019).

Some interviewed do not see food waste as an issue because they think they waste just as much or less than others around them and that it is a social norm to waste food (Graham-Rowe et al., 2014). Social norms have been shown to increase recycling rates and other pro-environmental behavior changes. When people perceive others to believe and engage in recycling, they are more likely to follow suit (Geiger et al., 2019). This idea could be applied to food waste based on these findings. People make decisions, whether consciously or subconsciously, based on these social norms of what they believe others are doing. However, invisible behaviors are more challenging to change through social norms (McKenzie-Mohr, 2012). Since much of the food waste we aim to target comes from within homes, it is unlikely to be seen by others, leading to the idea that food waste is the status quo. Weekly waste pickups also lead to households' inability to see how much waste they produce over time. These households do not have increased garbage hauling fees for producing more waste and will not see methane emissions from their waste at the landfill.   People do not need to confront the consequences of waste, which creates a barrier to using social norms. To utilize social norms, showcasing people who have reduced their waste may be required. Another barrier related to awareness is that consumers think the fault lies in producers and retailers, and they are not a part of the problem (Graham-Rowe, 2014). Since 50% or more of wasted food stems from the consumer level, increasing consumers' perceived behavioral control of wasting food could empower them. Perceived behavioral control is a concept in the Theory of Planned Behavior that impacts the intention to perform a behavior based on how possible it seems and how much a person believes it will make a difference in their values and identity.

Even if the relevant information is spread enough to motivate an individual to waste less, this can conflict with other motivations, creating another barrier. For example, convenience is essential to many consumers. People will buy in larger quantities to reduce grocery shopping time, even if it spoils some items (Graham-Rowe et al., 2014). Foodborne illnesses are also seen as an inconvenience that many are not willing to risk. If they think

there is a question of whether food is spoiled, they may err on the side of caution, leading to more waste.

Another conflicting motivation is that of over-purchasing. Sometimes, this behavior is intentional in the case of hosting events and the desire to be a 'good provider' for the family. These providers see it as their responsibility to purchase sufficient quantity and a variety of quality and nutritious foods (Evans, 2012; Graham-Rowe, 2014; Visschers, 2016). They would instead provide a plethora of options rather than too little food. This is common in households with children with changing palettes that add unpredictability. More children in a household have been found to correlate to higher rates of food waste, though less waste per capita (Visschers, 2016). These conflicting food-related goals cause consumers to prioritize those with the most significant impact on daily life rather than abstract thoughts of environmental impact.

Finally, many barriers to food waste reduction come from a need for more opportunities for the consumer. Some obstacles to consider regarding the built environment are space constraints for food storage, inadequate cooling technology, needing to drive farther to stock up on foods, access to transportation, and access to disposal services. Disposal could entail composting at home, which those in multi-family housing likely do not have the opportunity to do. Disposal opportunities could also come from a curbside composting collection service, which is only sometimes available.

Barriers can arise at any stage of the food chain: planning and purchasing, storage and consumption, and disposal.

Intervention Strategies:

The literature on interventions to reduce food-wasting behavior is quickly emerging. Few peer-reviewed studies in the United States have measured interventions' effects on these behaviors so far. However, these couple studies, combined with what researchers have found in other countries, can give insight into developing a Community-Based Social Marketing strategy.

Education:

For significant behavior changes to occur within the household, residents must first realize the consequences of their waste and discover the benefits of saving food from landfills. However, more than information campaigns alone will be required to decrease waste dramatically (Abrahamse & Steg, 2013). There is mixed evidence that education or informational interventions alone are enough to change behavior. A meta-analysis found that education efforts have the most significant effect size out of all studies interventions related to food waste (Tian, 2022). However, education is often combined with another method, which is hard to untangle when looking at results. This implies that education materials and additional social marketing techniques will have a more significant effect.

The first intervention study was designed for residents in Phoenix, Arizona (Christopher et al., 2021). This study specifically targeted adult English speakers in single-family homes who were the primary food shoppers of their household. The intervention used in this study was a 5-module online education tool. The tool uses multiple media formats to engage the participants. Each module was centered around the values of finances, environmental impact, and health impact of wasted food. Participants were prompted to complete one module per week. The results were measured through pre- and post-surveys, collection kits to collect each week's wasted food weight, and an exit interview to gauge feedback about the study. By the end of five weeks, wasted food from these homes had decreased 27.85% from baseline. One limitation of this study is that it focused on a relatively small demographic of single-family home dwellers. It also concluded that low-income participants correlated to lower study completion rates than high-income. This implies there could be additional barriers at work to focus on targeting these families. The Arizona study differs from other studies in that people's perceived food waste correlated with their actual amounts of food waste. Podcasts and videos were this study's most helpful information delivery format based on the participants' exit interviews (Christopher et al., 2021).

Engagement:

Asking the public to set goals or make a commitment to a behavior is a standard tool in CBSM. Public commitments effectively change behaviors related to resource conservation and sustainability (Abrahamse, Steg, 2013). Two field studies by Cooper et al., published in 2023, looked at food waste behaviors in Canada and the United States. In both cases, participants were asked to set a day of the week as a "use-up day," where they select ingredients that will spoil soon. Setting this goal and materials to help get creative with these meals reduced self-reported food waste. Both studies in this report used a control group of those who did not receive information booklets but were given the same questionnaire regarding food management. This request with motivational messaging led to a 13% difference in food waste compared to the control group in the United States (Cooper et al., 2023).

Social Norms:

Social norms play on the role that other people's behavior has on our own. While social norms may be more challenging to utilize as motivation for food waste behaviors not seen by others, messaging that uses social norms may prove effective. A trial in Washington, D.C., found that after receiving educational materials, those prompted with a statistic showing how others in D.C. feel and act about food waste decreased their self-reported amount of food waste over six weeks (Blondin & Atwood, 2022). This study also occurred during COVID-19, which likely affected results as the control group's weekly waste increased. In contrast, the waste levels of the two social norm intervention groups remained statistically unchanged.

More specifically, when using social norms, there is some evidence that the type of norm statement used in the message can affect the behaviors or perceptions that are shifted. A study on social media messaging found that using a static norm message significantly increased knowledge of the magnitude of food waste. In contrast, a dynamic norm message left participants more likely to share the information with someone (Blondin & Atwood, 2022). In this case, the static norm states the current prevalence of food waste reduction efforts, while a dynamic norm informs of future trends of food reduction, implying that they should join in the behavior as well. The dynamic norm influencing participants wanting to share information with others suggests that individuals could be more willing to act when given these messages than just understanding that there is an issue.

Co-designing an intervention and selecting the specific end-state behaviors to target with the target group has been shown to positively impact the intervention's success (Kim et al., 2019). The residents incorporated into developing a CBSM strategy can have valuable insights that experts may otherwise overlook.

Social diffusion:

Social diffusion occurs when a behavior becomes a norm. Behaviors influenced by social diffusion can stem from important people in someone's life to social media. Social diffusion has proven to be a valuable strategy for CBSM. With pro-environmental behaviors, it is best to start by engaging with a group with a high willingness and motivation to act. Then, this group is used as leverage to create new social norms and influence others (Stockoli, 2018). Individuals are not stagnant in these groups. They may shift to other groups through lifestyle changes or gain knowledge and develop a system for optimal food management as they age. There is also evidence that groups with more social interactions could be important to start with in social diffusion, as they may be more likely influenced by social diffusion interventions (Abrahamse & Steg, 2013). Groups that may fall into this segment would be students or employees. College students could be an essential group to target as they are going through a transitional period, which is the best time to adopt new behaviors and turn them into habits (McKenzie-Mohr, 2012). Many studies suggest it is more important to segment the populations based on their current behaviors and willingness to adopt new ones rather than socio-demographic factors (Stockoli, 2018). No detailed research indicates how or if audience segmentation with food waste should be based on sociodemographic factors (NASEM, 2020). This does not mean that additional attention should not be paid to different socio-demographic factors. Still, more information will have to be gained through public meetings to determine if there are specific barriers that these groups face regarding food waste.

While many articles explore food waste and posit interventions that could be effective, there needs to be more research, particularly within the United States, of interventions that have been implemented and their success measured. There are some papers discussing the use of 'smart bins' and other technology to reduce food waste.

Still, these studies were not considered as they are not feasible to implement on a large scale for Social Behavior Marketing. In the peer-reviewed literature, only three studies have been found to fit these criteria.

Chapter 5: DISCUSSION

The literature regarding interventions is new and emerging. Most studies conducted have been on populations in other countries, primarily Europe. While these studies can give us a broad idea of what to expect in Lincoln, these populations likely have different values, cultural influences, and food environments. An array of intervention types have shown promise in reducing household food waste. This also tells us that there is not a one-size-fits-all approach that needs to be taken for every population. The literature does show that combining strategies will be more effective than just one alone. The most effective interventions will reduce multiple barriers to consumers' motivation, opportunity, or ability. The most important takeaway for the social marketing company will be to involve the public in designing the messaging and intervention styles used.

Knowledge of the issues that food waste causes will not be enough to change most consumers' behaviors without combining other CBSM strategies. Goal setting, commitments, and social norms all provide promise in reducing food-wasting behaviors.

The pertinent takeaways for the social marketing firm when developing messages for the community should be to:

- Take residents' suggestions into consideration. One or more public meeting should be held in the development stage of the strategy. This ensures buy-in from the public and that they feel heard in what is currently causing them to waste the food they purchase.
- Utilize multiple strategies. Whatever strategies are selected, an educational component should be included that puts the issue of food waste in a context that is relevant to consumers.

- Social norms and social diffusion will be easiest to achieve in the UNL student population due to the increased social interaction and comparison on campus.
- If social norms are used as a strategy, intention should be put into developing what type of norm statement is used based on the specific behavior desired.

Limitations:

Current available studies include many limitations. Measuring food waste on a household level is difficult, time-consuming, and costly. If the data collection method is self-reported, participants are likelier to report less waste than what occurred (Visschers, 2016). On the other hand, a recent study found that self-reported results correlated with the corresponding curbside waste audits conducted (Shu et al., 2023).

As previously mentioned, most studies have been conducted in Europe, particularly those that include data-driven results from surveys and interventions. The food systems in these countries differ significantly from those in the United States; therefore, societal factors could be vastly different in American populations.

Evaluations of community campaigns are best compared to control groups rather than pre/post-intervention for wasting food (Shu et al., 2023). This is because if the same group is being evaluated at different points, changes can result due to seasons, special events, and other factors. These waste audits show waste generated at a specific time, and there can be drastic variations whose factors are not considered. Most community-based interventions are focused on comparing pre- and post-intervention, which leaves a mystery about the factors that could be at play in these studies (Grilli & Curtis, 2021). From the Arizona study, we can see that without a control group, there would not have been a significant shift from pre- to post-intervention since experiment groups had similar amounts of waste. In contrast, the control group significantly increased their waste (Christopher et al., 2021).

Even when studies directly measure the amount of food wasted, they cannot account for food that ends up down the drain or in backyard composting. While some studies have follow-up surveys or measurements taken a few

weeks post-intervention, there still needs to be more assessments of long-term behavior change related to food waste.

COMPETENCIES

Foundational:

MPHF7	Assess population needs, assets, and capacities that affect communities' health.

Through this project, I can assess the characteristics of different target populations. Waste reduction leads to reduced greenhouse gases in a community, which harm our environment and lungs. The survey will allow me to assess motivators and barriers to waste reduction and recycling.

MPHF18- Select communication strategies for different audiences and sectors

There are three target populations in this project. The literature will be reviewed to determine if there is a way to proceed with tailoring messaging to each of these groups.

Concentration:

EOHMPH1	Analyze sources of exposure in the workplace and the environment that can cause health risks to humans or degradation of ecosystems.

Greenhouse gases will be the exposure researched in this report. Methane is the primary gas that will be focused on, as it is created when organic material ends up in a landfill. Greenhouse gases directly cause harm to human health. These gases are the drivers of climate change, which is degrading the environment in a plethora

of ways including, but not limited to, vector-borne illnesses, increased asthma rates, food supply chain disruptions, melting ice caps, urban island heat effects, electricity grid constraints, and extreme weather events.

EOHMPH8   Examine information sources and public health indicators in occupational and environmental health.

I will review the current literature on greenhouse gas emissions caused by landfills. I will also examine sources for methods and barriers to reducing waste in a community. The primary target populations used a medley of health indicators to be labeled disadvantaged census tracts.

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