

Food: Too Good to Waste Pilot

A background research report for the West Coast
Climate and Materials Management Forum



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COMMUNITY FOOD WASTE PREVENTION PILOT: A RESEARCH ANALYSIS OF HOUSEHOLD FOOD WASTE AND WASTE PREVENTION BEHAVIORS

ABSTRACT

This report discusses the literature and research pertaining to the amount of food waste generated, the environmental impact of food waste, and opportunities to change household behaviors to reduce food waste. Over 40 percent of the food produced or imported for domestic consumption in the United States is lost, with over one-fourth of household food purchases going to waste. Food waste impacts the environment through carbon-intensive production processes and its decomposition in landfills, which releases methane, a potent greenhouse gas. Additionally, by one estimate, food waste accounts for more than a quarter of total freshwater use.

This report represents the first phase of planning a Community Food Waste Prevention Pilot aimed at reducing food waste. This phase focuses on gaining an understanding of the amount of food waste and sources of food waste associated with household consumption as well as identifying potential behaviors that reduce food waste. The Community Food Waste Prevention Pilot focuses on source reduction, an important issue for communities. Source reduction minimizes the quantity and toxicity of materials that later need to be disposed of and is identified under the Resource Conservation and Recovery Act as a key strategy for achieving our environmental goals. Source reduction also helps to reduce greenhouse gas (GHG) emissions, which are regulated pollutants under the Clean Air Act.

The report provides a review of research detailing food waste estimates including: food waste as a percentage of the waste stream; per capita food waste; and food waste by food types. The major sources of consumer food waste are: inedible share (e.g. apple cores), cooking and preparation discards, discards due to expired use-by or open dates, discards due to over-preparation of foods and plate waste, and spoilage. Estimates of the environmental impact of food waste are also covered in the report. In addition, the report summarizes the research on opportunities to reduce household food waste by focusing on shopping, storage, preparation, and eating behaviors.

1.0 INTRODUCTION

The purpose of this report is to provide background research for developing a Community Food Waste Prevention Pilot program. The Pilot will use community-based social marketing methods to reduce food waste and its associated environmental impacts. Food waste refers to food and beverages that were once available for human consumption but are discarded without being eaten.¹ The Pilot is a project of the West Coast Climate and Materials Management Forum (the Forum), an EPA-led partnership of western cities and states that are developing and sharing ways to integrate sustainable materials management policies and practices into climate actions. EcoPraxis and TetraTech EM Inc. were contracted to perform the analysis contained in this report with guidance from the EPA and their partners. This report and other background documents were used to inform the design and implementation of the Community Food Waste Prevention Pilot program called *Food: Too Good to Waste*.

For both environmental and economic reasons, as well as global population increases, food waste is emerging as an issue of significant consequence. Over 40 percent of the food produced or imported for domestic consumption in the United States is lost to the landfill and over a quarter of household food purchases go to waste.² Food waste has been identified as a major source of greenhouse gas emissions and other negative environmental impacts. By one estimate, food waste accounts for more than one quarter of total freshwater use and approximately four percent of oil consumption in the U.S.³

Understanding the patterns of food consumption and waste behaviors can increase our chances of developing successful strategies to reduce food waste and its environmental impacts. Additionally, food loss impacts food security and other social issues. However, this report is focused on the environmental impacts of food waste and the potential for promoting behaviors that reduce these environmental impacts.

Consumption is generally defined in economic circles as the final purchase of goods and services. Sustainable consumption more broadly refers to the range of consumer behaviors involving the “acquisition, use, and disposal” of products, services, and practices such that environmental health, economic vitality, and quality of life are maintained or restored for current and future generations.⁴ For purposes of this report, sustainable food consumption means to attempt to meet the food needs of “present and future generations in ways that are environmentally, economically, and socially sustainable.”⁵

1.1 SUSTAINABLE CONSUMPTION

In recent decades, researchers have begun to address the question of what can be done to slow resource depletion in the face of some very daunting environmental challenges. The advanced industrial economies, with just 20 percent of the world population, account for roughly 80 percent of the life cycle environmental impacts of consumption. This level of consumption is far from sustainable.⁶

¹ Muth, Mary et al., “Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors.” (USDA ERS Report, 2007).

² (Economic Research Service, 2010).

<http://ers.usda.gov/Data/FoodConsumption/FoodGuideSpreadsheets.htm>.

³ Hall, Kevin D. et al., “The Progressive Increase of Food Waste in America and Its Environmental Impact.” *PLoS ONE* 4, no. 11 (2009).

⁴ Jackson, Tim, “Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change.” (2005). <http://www.comminit.com/en/node/219688/306>.

⁵ “United Nations Guidelines for Consumer Protection.” (United Nations, 1995).

<http://www.unep.fr/scp/sc/guidelines.htm>

⁶ Tukker, Arnold et al., “Fostering Change to Sustainable Production and Consumption: An Evidence-Based View.” *Journal of Cleaner Production* 16, pp. 1218-1225 (2008).

Boyden, Stephen and Stephen Dovers, “Natural-Resource Consumption and Its Environmental Impacts in the Western World. Impacts of Increasing per Capita Consumption.” *Ambio* Vol. 21, No. 1, Population, Natural Resources and Development. pp. 63-69 (1992).

As solving our environmental challenges becomes ever more urgent, it also has become more apparent that addressing our individual choices about consumption is key to reducing our impact on the environment.⁷

Generally, there are three ways to reduce the environmental pressures from consumption: greening products and production processes; shifting demand to lower-impact consumption categories; and reducing waste in the consumption process.⁸ Yet, between 1970 and 1995 the worldwide consumption rate of natural resources doubled.⁹

A key barrier to sustainable consumption behaviors is “lock-in”. Lock-in occurs when an existing system’s organization – the mesh of consumer habits, lifestyles, technologies, social norms and values, markets, and other socio-economic conditions – makes change difficult.¹⁰ In the case of food, intervening to change personal food-related choices can be difficult and controversial. In fact, consumers are more open to changing their shopping habits than what they eat.¹¹ For example, reducing food waste by encouraging consumers to buy more seasonal and local food is generally a more acceptable goal than telling them to eat foods with lower environmental impacts.¹²

Another key barrier to sustainable consumption behaviors is the variety of factors that influence behavior adoption. While some consumers may favor reducing their food consumption impact, that motivation alone does not always translate to their behaviors. Research shows that attitudes alone are poor predictors of consumer behavior.¹³

Despite the challenges of developing policy and programs to affect behavioral change, sustainable consumption strategies promise significant outcomes, especially as they become more nuanced and in tune with wider societal values.¹⁴ An important tool in the sustainable consumption toolbox is community-based social marketing programs.

⁷ Jackson, Tim, “Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change.” (2005). <http://www.comminit.com/en/node/219688/306>.

McKenzie-Mohr, Doug, “Social Marketing to Protect the Environment: What Works.” (Sage Publications Inc., 2011).

⁸ Tukker, Arnold et al., “Fostering Change to Sustainable Production and Consumption: An Evidence-Based View.” *Journal of Cleaner Production* 16. pp. 1218-1225 (2008).

⁹ U.S. EPA, “Sustainable Materials Management: The Road Ahead.” (2009).

<http://www.epa.gov/osw/inforesources/pubs/vision2.pdf>

¹⁰ Tukker, Arnold et al., “Fostering Change to Sustainable Production and Consumption: An Evidence-Based View.” *Journal of Cleaner Production* 16. pp. 1218-1225 (2008).

¹¹ Owen, Liz et al., “Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs.” (2007).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Public+Understanding+of+Sustainable+Consumption+of+Food#0>.

¹² Power, Kate, “Introducing Behaviour Changes towards Sustainable Food Consumption.” (2010).

¹³ Nurse, Gretchen et al., “Understanding the Connections between Consumer Motivations and Buying Behavior: The Case of the Local Food System Movement.” Paper for Southern Agricultural Economics Association Annual Meeting (2010).

¹⁴ Tukker, Arnold et al., “Fostering Change to Sustainable Production and Consumption: An Evidence-Based View.” *Journal of Cleaner Production* 16. pp. 1218-1225 (2008).

1.2 COMMUNITY-BASED SOCIAL MARKETING

Community-based social marketing is an approach to driving behavioral change through community initiatives that remove barriers to desired behaviors, while simultaneously enhancing those behaviors advantages.¹⁵ It relies on a series of key steps as an approach to designing programs (see sidebar).

The first step in developing a community-based social marketing program is to select which behaviors to promote, beginning with a determination of how the issue under study is affected by a particular sector. For this pilot, the issue is food waste and the sector is households in the western states (EPA Regions 9 and 10). Information is then gathered to identify and compare behaviors of interest in terms of their impact, penetration, and probability. The assessment provides guidance in identifying which behaviors are potential candidates for large-scale change.

The second step in program development is to identify barriers and benefits associated with the behaviors selected for change. For the pilot, this step involves both a literature review and supplemental research on key barriers and benefits. See section 4.3 for next steps in the Pilot's development and implementation.

Steps in a Community-Based Social Marketing Approach

1. Identify desired behaviors
2. Identify barriers and benefits of desired behaviors
3. Design pilot program with behavior change strategies and messaging
4. Implement pilot program
5. Evaluate pilot program
6. Replicate successful strategies from pilot

The information gathered through the background research and focus groups is then used to design behavioral change strategies and associated messages, which are next deployed in a pilot. The *Food: Too Good to Waste* Pilot is scheduled to be implemented in Fall 2012. Upon evaluation of the pilot, the final phase of a community-based social marketing program is to roll out the pilot's successful strategies across the sector of interest.

In designing strategies, community-based social marketing makes use of insights into the importance of social norms and community engagement in changing behaviors.¹⁶ Community-based social marketing practitioners have developed a number of social-psychological tools, such as commitments, prompts, and signals, to reinforce desired behaviors.¹⁷ Careful design of strategies has proven to lead to behavior change.

¹⁵ McKenzie-Mohr, Doug, "Social Marketing to Protect the Environment: What Works." (Sage Publications Inc., 2011).

¹⁶ Jackson, Tim, "Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change." (2005). <http://www.comminit.com/en/node/219688/306>.

¹⁷ McKenzie-Mohr, Doug, "Social Marketing to Protect the Environment: What Works." (Sage Publications Inc., 2011).

1.3 RESEARCH FRAMEWORK AND SOURCES

This report's objective is to provide background research in order to identify three to five behavioral changes that represent opportunities to substantially reduce food waste and its environmental impacts. This represents the first step in the community-based social marketing approach.

A research framework was developed to identify, analyze and assess potential behaviors for targeting in the pilot. The framework informs the organization of the report as follows:

Section 2: Opportunities to Reduce Food Waste

Section 2 presents an analysis of the opportunities to reduce food waste in terms of the amounts of food wasted and the impact of these losses. Generally, it focuses on quantitative findings.

Section 3: Opportunities for Change

Section 3 presents the research on household consumption and waste behaviors and identifies which behaviors represent key opportunities for change. Generally, it focuses on qualitative findings.

Section 4: Opportunities Assessment

Section 4 presents an assessment of potential behavioral changes in terms of their impact, penetration, and probability.

This report draws on recent research on sustainable food consumption and food waste. One of the major sources for this research is a series of reports on food waste commissioned by the Waste and Resources Action (WRAP) Programme in the United Kingdom (U.K.). The most recent reports include a comprehensive waste quantification study and two consumer research reports on fruit and vegetable waste and food dates and portion sizes.¹⁸ The WRAP sponsored program, *Love Food, Hate Waste*, serves as a potential model for the Community Food Waste Prevention Pilot.¹⁹

1.4 RESEARCH TERMS AND SCOPE OF RESEARCH

In analyzing and discussing food consumption and waste behaviors, it is useful to define the interrelation of various terms and concepts relating to those behaviors and also to specify how they will be used in the context of the analysis.

The terms 'food loss' and 'food waste' are often used interchangeably. Technically, food loss, as defined by the United States Department of Agriculture (USDA), refers to food and beverages that were once available for human consumption but is discarded without being eaten, that is, it excludes the non-edible portions of food waste.²⁰

With regard to food, over-consumption includes both waste behaviors (e.g., wasting of food that could have been eaten) and excessive consumption (e.g., eating more food than is needed to meet one's nutritional requirements). To date, the research has focused primarily on waste behaviors, or 'wasteful consumption', and this focus is reflected in the content of this report.

¹⁸ Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009). <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>.

Johnson, David et al., "Helping Consumers Reduce Fruit and Vegetable Waste: Final Report." (2008).

http://www.fcrn.org.uk/sites/default/files/Helping_consumers_reduce_waste_Final_report.pdf.

Lyndhurst, Brook and ESA, "Helping Consumers Reduce Food Waste – A Retail Survey." (WRAP Report, 2010).

¹⁹ Falcon, Julia et al., "Love Food Champions." (WRAP Report, 2008). http://www.wrap.org.uk/downloads/LFC_draft_FINAL_report_171008-FINAL.09ab9907.6083.pdf

²⁰ Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).

At the same time, consumption behaviors influence waste behaviors: consumers buy food based on what they want to eat, not what they intend to waste. However, what motivates consumers to buy food may result in an excess of food, leading to waste. Thus, the literature does address many consumption motivators, such as what factors influence shopping for food.

In the context of this report, consumption also refers to the using up of resources. With regard to food, there are both direct and indirect routes to reducing resource depletion. Resource depletion can be reduced by avoiding excessive household consumption and reducing household food waste – the direct route. The consumption of less resource-intensive products indirectly lowers resource consumption by reducing the amount of resources used upstream of consumption during the production, processing and distribution phases of the production-consumption cycle. As the largest impact of food waste is indirect (see Section 2.6), consuming less resource-intensive products is an important route to sustainable consumption.

With this in mind, it is important to note that in everyday usage, food consumption generally refers to eating. In this report, food consumption refers to a process involving a range of behaviors from pre-shop planning to final discard due to spoilage or over-preparation.

2.0 OPPORTUNITIES TO REDUCE FOOD WASTE

Waste characterization studies repeatedly show that food accounts for the greatest percentage of household waste going to landfills.²¹ In addition, food waste is composted (both in backyards and at commercial facilities), fed to pets, and discarded down drains and in garbage disposals. Reducing wasteful consumption, primarily through reducing household discards of edible food, is one of the pilot's two behavioral goals. Food waste estimates by food type are particularly useful in discerning wasteful consumption patterns.

The second goal involves shifting consumption to less resource-intensive food choices. To estimate the resource intensity of different food choices we need to determine the total amounts of food waste, inclusive of production, retail, and consumer-level losses, and the impact by unit of consumption for different food choices.

This section of the report presents evidence on the scale of food waste in the U.S. Section 2.1 reviews the methodologies for estimating loss. Section 2.2 provides estimates of total food loss covering all phases of the production-consumption cycle. Waste estimates by food type, by demographics and market segments, and by waste type, are presented in Sections 2.3 through 2.5 respectively. Section 2.6 covers estimates on the environmental impact of food waste presented in the literature.

2.1 ESTIMATING FOOD WASTE

Estimates of household food waste vary according to the research purpose and methods.²² Muth, Karns, and others (2011) identify four methodologies for estimating consumer-level food waste and their strengths and weaknesses. The four are:

- Dietary recall: Individuals keep diaries or are interviewed on their food discards. The drawback of this method is that study participants tend to alter their behavior because of observation. Its strength is the possibility of collecting inter-related demographic and socioeconomic data.
- Archeological: Trained observers examine garbage (and, more recently, compost) and then estimate or measure food discards. This method misses liquids, food fed to pets, food disposed in garbage disposals, and food that is composted in backyards. This method usually does not account for different food types, or edible and non-edible food, as food waste is grouped together as one category. Because this method is also costly, there are limited data.
- Plate examination: Researchers examine and then estimate or measure plate waste. This method only covers plate waste.
- Inferential: Calculations are made using secondary data on food purchases and food consumption. This method addresses all at home food losses but there are a limited number of data sets and their accuracy may be an issue.

It should be noted that none of these methods accounts for over-eating as a factor in over-consumption; Overeating lies outside the scope of this report.

²¹ U.S. EPA, "Basic Information about Food Waste." (2012).

<http://www.epa.gov/osw/conservation/materials/organics/food/fd-basic.htm>

²² Griffin, Mary et al., "An analysis of a community food waste stream." *Agriculture and Human Values* 26, no. 1-2 pp. 67-81 (December 5, 2008). <http://www.springerlink.com/index/10.1007/s10460-008-9178-1>.

Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).

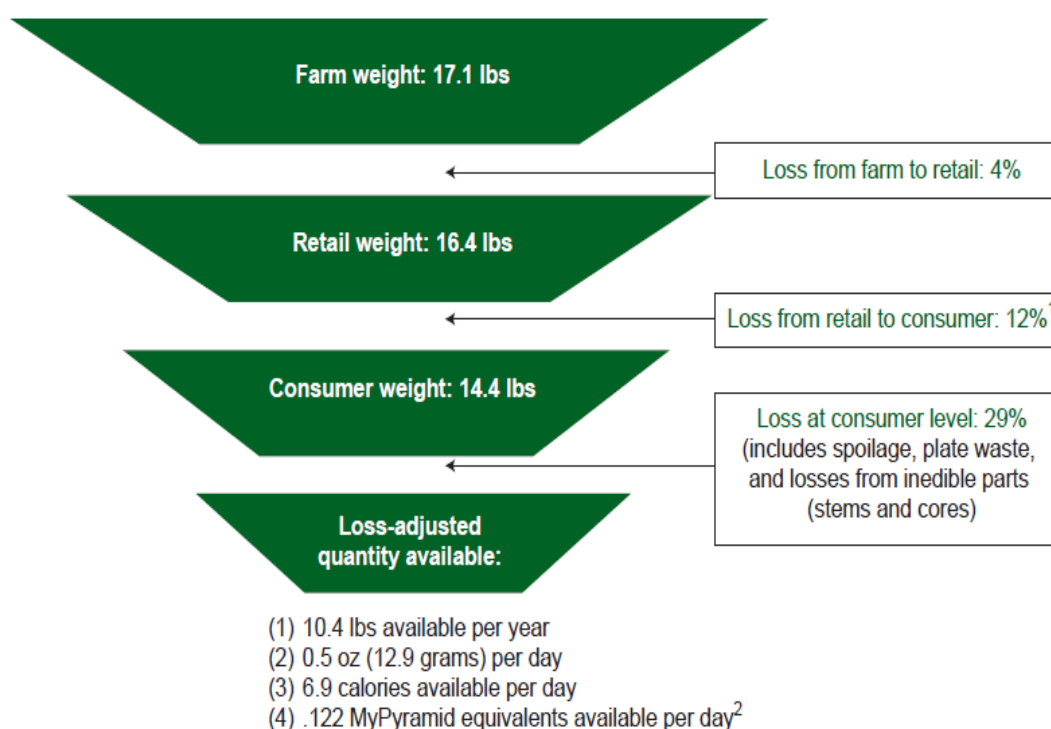
Waste and compost characterizations are examples of the archaeological method. The USDA's Economic Research Service (ERS) uses the inferential method (discussed below) to track food availability. A major difference in the inferential approach and data obtained through waste characterizations is that the waste composition studies do not separate edible food from the inedible share (e.g., peels, pits, shells, and bones).

The ERS publishes a detailed food availability time-series for the purpose of diet and nutrition monitoring.²³ (This is the source data for the loss estimates depicted in Figures 2 through 6.) The data series includes food availability estimates adjusted for spoilage and waste for over 250 generic individual food products aggregated into the following food groups: vegetables, dairy and dairy beverages, grains, meat, caloric sweeteners, fruits and fruit juices, poultry, fats and oils, fish (and shellfish), eggs, and nuts (see Figure 3 below).

The loss estimates cover three general types of losses as depicted in Figure 1:

- Primary-Level Losses: These account for the difference between farm weight and retail weight.
- Retail-Level Losses: These account for the difference between retail and consumer weights (weight at purchase).
- Consumer-Level Losses: These includes losses for food consumed at home and away from home (e.g., at restaurants, institutions such as hospitals, etc.).

Figure 1: Loss-adjusted Food Availability Data for Fresh Apples, Per Capita, 2005



Reprinted from Buzby et al., 2009

²³ Buzby, Jean C. et al., "Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2009).
<http://www.ers.usda.gov/publications/eib44/eib44.pdf>.

Consumer-level losses can be further disaggregated into edible (or avoidable food waste) and non-edible shares (e.g., bones, rinds, shells, and cores). Non-edible shares are calculated as a percentage by weight of the whole item. For example, it's estimated that the core and stem, the non-edible portions of the apple, make up 10 percent of an apple by weight on average. Reducing inedible food losses requires reducing the consumption of food items with high non-edible portions, for example, purchasing fewer pineapples or pumpkins.

The term 'avoidable food loss' is used to describe the edible portions of food (see, for example, the WRAP 2009 report, *The Food We Waste*). The term highlights the potential savings from reducing this type of waste.

The ERS has several extensive research efforts underway to update and revise estimates at all levels. Of interest to this project are the studies focusing on food loss in supermarkets and at home.²⁴ The supermarket study analyzed food losses in supermarkets and posited how losses of different foods were related to consumer behavior. The consumer level study compares estimates of total U.S. household retail purchases with U.S. at-home consumption for each food in the data series. The purchase panel data consists of data from 125,000 households who weekly scan their retail food purchases with a handheld scanner. The at-home consumption figures come from the 2003-2004 National Health and Nutrition Examination Survey (NHANES) in which 10,000 respondents recorded their food consumption for two 24 hour recall periods. The estimates were reviewed by a panel of experts.²⁵ The ERS also conducted an extensive literature review of consumer-level food loss prior to its 2011 data analysis.²⁶

For the purpose of this research and the pilot, the exact percentages of discards are less important than the pattern of consumption, that is, what food types represent opportunities to significantly reduce the impacts from food waste.

2.2 GROSS ESTIMATES OF FOOD WASTE

It is generally acknowledged that there is a lack of data on food waste, but as concern regarding the impacts of food consumption has grown, various attempts have been made to quantify the magnitude of the problem.²⁷ These include estimates of food waste as a percentage of the waste stream; estimates of per capita food waste; and estimates of the percentage of food waste by types of foods (e.g., meat, fruits) and food item (e.g., lamb, collard greens).

Gross estimates are covered in this section while loss by food type is covered in Section 2.3. Data findings on waste by demographics (e.g., age, income) and market segments (e.g., young professionals) and on loss by type of household food waste (e.g., unopened packages, plate waste) are reviewed in Sections 2.4 and 2.5 respectively.

²⁴ Buzby, Jean C. et al., "Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2009).
<http://www.ers.usda.gov/publications/eib44/eib44.pdf>.

Muth, Mary K. et al., "Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2011).

²⁵ Muth, Mary K. et al., "Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2011).

²⁶ Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).

²⁷ Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).
Gustavsson, Jenny et al., "Global Food Losses and Food Waste: Extent, Causes and Prevention." Report for Swedish Institute for Food and Biotechnology (2011).
http://www.fao.org/fileadmin/user_upload/ags/publications/GFL_web.pdf.

2.2.1 Food Loss as a Percentage of Total Food Production

The ERS estimates that 44 percent of all food produced or imported for domestic consumption in the U.S. was lost in 2008.²⁸ This compares to the roughly one-third that is lost or wasted globally.²⁹

Hall and others (2009) estimate that food waste in the U.S. has progressively increased from about 30 percent of the available food supply in 1974 to almost 40 percent in recent years using an inferential mathematical model based on Food and Agriculture Organization of the United Nations data.³⁰

2.2.2 Food Waste as a Percentage of the Waste Stream

The EPA estimates that food scraps comprised 13.9 percent of the municipal solid waste (MSW) stream in 2010.³¹ As both residential and commercial sources are included in MSW estimates, food as a percentage of MSW is less than the percentage found in the residential waste stream. Still, food scraps account for the second largest portion by material type of MSW, behind paper and yard trimmings, and a significant portion by product category (such as packaging and containers and non-durable goods).

A review of recent waste composition studies at both county and state levels for three states in EPA Regions 9 and 10 (California, Oregon, and Washington) reveals that food waste is the number one component by weight of the household waste stream. However, there is a wide range in the percentages as shown in Table 1 – from 14.3 percent of residential waste in King County to 42.2 percent for single family route collection in San Francisco.

Table 1 also provides a breakout of the vegetative and non-vegetative portions of food waste (when data was available). Vegetative, as used in the referenced studies, means “of or relating to plant life” such as fruits and vegetables. (It does not include the yard waste fraction of solid waste which is accounted for in a separate category.) Non-vegetative food waste is comprised of all other types of food waste. Vegetative waste comprised over three-fourths of the food identified in the 2009 King County characterization. Similar ratios of vegetative to non-vegetative were found elsewhere, indicating that fruit and vegetable waste comprise the greater portion of food waste discarded into landfills.

²⁸ (Economic Research Service, 2010).

<http://ers.usda.gov/Data/FoodConsumption/FoodGuideSpreadsheets.htm>.

²⁹ Gustavsson, Jenny et al., “Global Food Losses and Food Waste: Extent, Causes and Prevention.” Report for Swedish Institute for Food and Biotechnology (2011).

³⁰ Hall, Kevin D. et al., “The Progressive Increase of Food Waste in America and Its Environmental Impact.” *PLoS ONE* 4, no. 11 (2009).

³¹ U.S. EPA, “Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010.” (2010). http://www.epa.gov/osw/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf

Table 1: Comparison of Residential Food Waste Characterizations

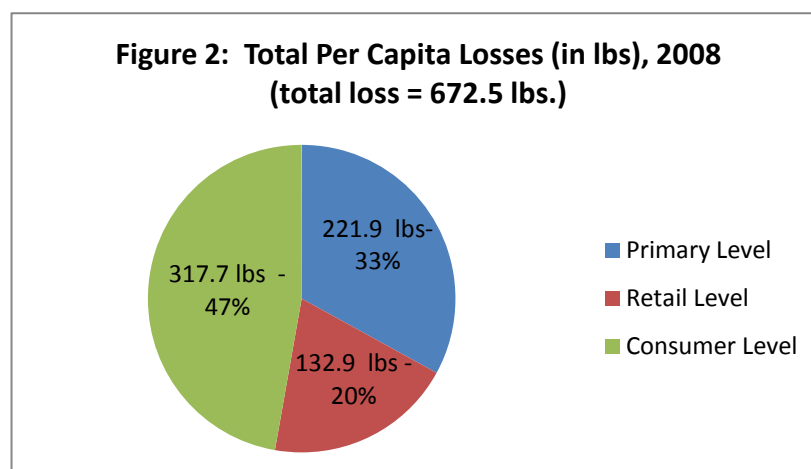
Locality	Report Year	Collection Method	Food (% by weight)	Vegetative/ Non-Vegetative Split (% by weight)	Compostable Soiled Paper (% by weight)
King County	2007	Self-Hauled	3.1%	Not available	Not available
King County	2007	All Residential	14.3%	10.2% Vegetative and 4.1% non-vegetative	5.6%
King County	2007	Commercially Collected Residential	17.0%	15.1% Vegetative and 5.9% Non-Vegetative	8.2%
Washington State	2009	All Residential	22.7%	17% Vegetative and 5.7% non-vegetative	5.0%
Oregon	2009-10	Residential Routes	28.9%	10% Vegetative, 2.4% non-vegetative; 16.6% not otherwise specified	3.75%
San Francisco	2006	All sources	26.8%	Not available	5.5%
San Francisco	2006	Multi Family	29.9%	Not available	6.1%
San Francisco	2006	Single Family	42.2%	Not available	6.4%

Sources: King County and Washington: Cascadia Consulting Group, 2008, 2009a, and 2009b; Oregon: Oregon Department of Environmental Quality, 2011; San Francisco: ESA, 2006

Two other generalizations might be inferred from the waste characterization data. The amount of food discarded into landfills varies by the method of collection (self-hauled versus commercially collected) and household residence type (single family versus multi-family residences). For example, food is only 3.1 percent of self-hauled waste in King County compared to 17 percent of the commercially collected waste stream. The low percentage for self-hauled waste likely indicates the availability of other disposal options such as commercial collection and feeding leftovers to animals.

2.2.3 Per Capita Weight Loss Estimates

Figure 2 shows per capita losses (by weight and percentage of total per capita weight) for the three general types of loss: production, retail and consumer level losses. Nearly half of food loss in the U.S. (47 percent in 2008) occurs at the consumer level.



Source: Economic Research Service, 2010 Loss-Adjusted Food Availability Spreadsheets

A recent inferential study for the Food and Agricultural Organization of the United Nations reports that North America has the highest per capita consumer level food loss of all regions of the world at nearly 40 percent of food available.³²

As noted in the previous section, there is wide variation in consumer-level food loss estimates according to the methods used to estimate loss and what is included in the loss estimates (for example, some estimates exclude non-edible shares). In a 1980 study, loss estimates for food purchased by consumers ranged from 7 percent to 35 percent.³³ In a more recent study, Griffin and others (2008) used earlier archeological research by Rathje (1992) to estimate the food waste for one county in upstate New York. The figure they used was 114 pounds per capita, which is much lower than the ERS 2008 estimate of 318 pounds.³⁴

One reason for the wide variation in estimates may be changing consumption patterns. Also, the lower end of the range cited above is more typically associated with archaeological and dietary recall methods of estimating waste, while the 35 percent estimate was the result of an inferential study. Waste characterization estimates also do not account for food discarded through disposal routes other than landfill, such as food that is commercially or backyard composted, flushed down drains, and fed to pets.

A comprehensive survey of household food waste by disposal route may reconcile some of this variation in estimates. It is worth noting that the ERS inferential estimate of 318 pounds per capita is very close to that of the 302.5 pounds calculated from the results of a comprehensive survey carried out by WRAP in the U.K.³⁵

WRAP estimates that in the U.K., 70 percent of household food waste is sent to landfill or recycling centers; 22 percent is poured or flushed to the sewer; and the remaining 8 percent is fed to pets or backyard composted.³⁶ The caveat in comparing the U.S. and the U.K. results is that WRAP estimates do not include food eaten away from home.

2.3 WASTE ESTIMATES BY FOOD TYPE

Waste estimates by food type are an important link between the amounts of food wasted and consumption behaviors. They are also important in calculating the environmental impacts of food waste and the consequent impacts of different consumption and waste behaviors.

As discussed in Section 2.1, the ERS publishes a detailed food availability time-series for the purpose of diet and nutrition monitoring.³⁷ This database is a rich source of food loss information by food type.

In addition to the breakout of food loss estimates by food type, this section includes a review of the research findings on food losses associated with two supra-food groups: fruit and vegetables and meat and dairy.

³² Gustavsson, Jenny et al., "Global Food Losses and Food Waste: Extent, Causes and Prevention." Report for Swedish Institute for Food and Biotechnology (2011).

³³ Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).

³⁴ Griffin, Mary et al., "An analysis of a community food waste stream." *Agriculture and Human Values* 26, no. 1-2 pp. 67-81 (December 5, 2008). <http://www.springerlink.com/index/10.1007/s10460-008-9178-1>.

³⁵ Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009). <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>.

³⁶ Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009). <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>.

³⁷ Buzby, Jean C. et al., "Supermarket Loss Estimates for Fresh Fruit, Vegetables, Meat, Poultry, and Seafood and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2009). <http://www.ers.usda.gov/publications/eib44/eib44.pdf>.

2.3.1 Per Capita Loss Estimates by Food Type

Figure 3 charts the per capita food weight losses, at the primary, retail, and consumer levels for the major dietary food types. The total loss per capita figures include all losses from “farm to fork.”

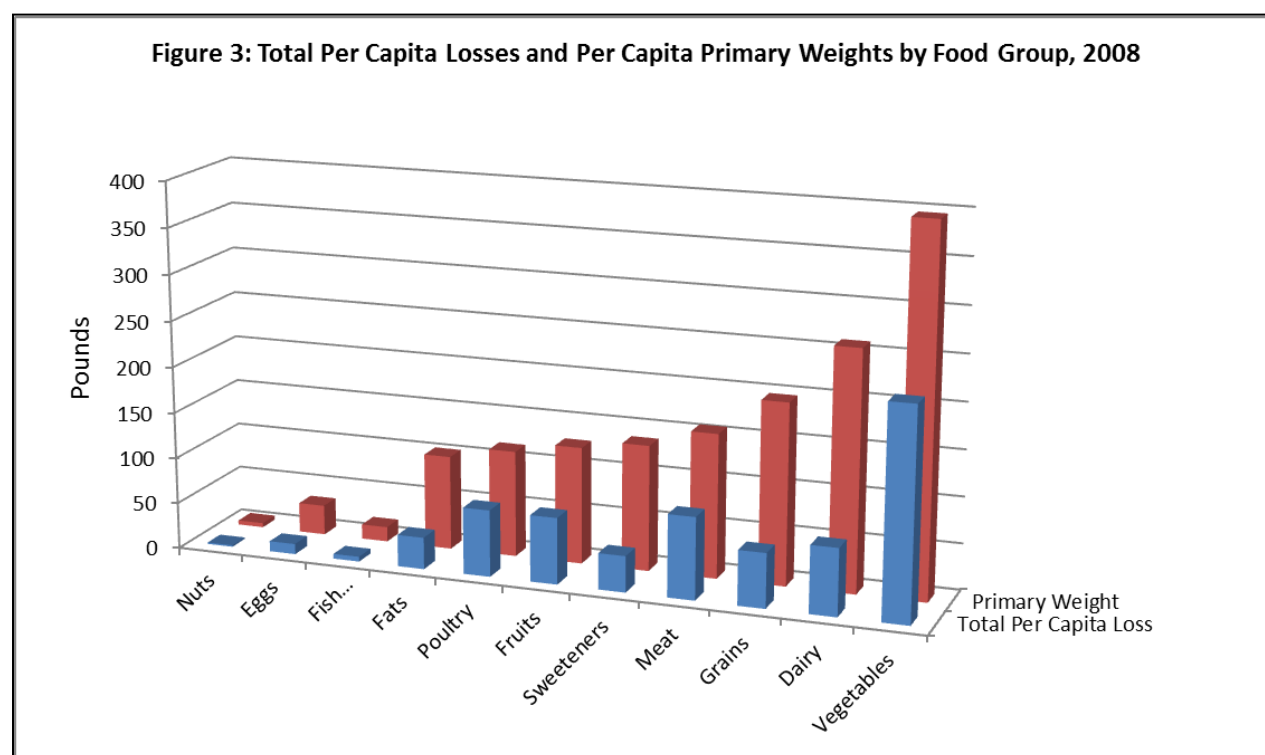
For comparison, Figure 3 also shows the primary weights for each food type. The primary weight numbers include the farm gate weights of food produced for domestic consumption as well as the weight of food imports. This comparison is useful to understanding that the impact of various consumption behaviors is a function of the percentage of food wasted by type as well as the amount of food consumed by type.

For example, as seen in Figure 3, dairy loss as a percentage of the primary weight is less than the loss percentage for that of poultry. However, as dairy consumption is much greater than that of poultry, the total per capita loss for dairy is about equal to that of poultry.

The total per capita losses as a percentage of primary weights are an indication of the perishability of a food type over its life cycle. Poultry is the most highly perishable food type with losses equal to 67 percent of its primary weight (The majority of this loss occurs at the production level). Vegetables, fruits, and red meat losses are the same percentage of their primary weights – 57 percent. Dairy is the least perishable food type at 28 percent.

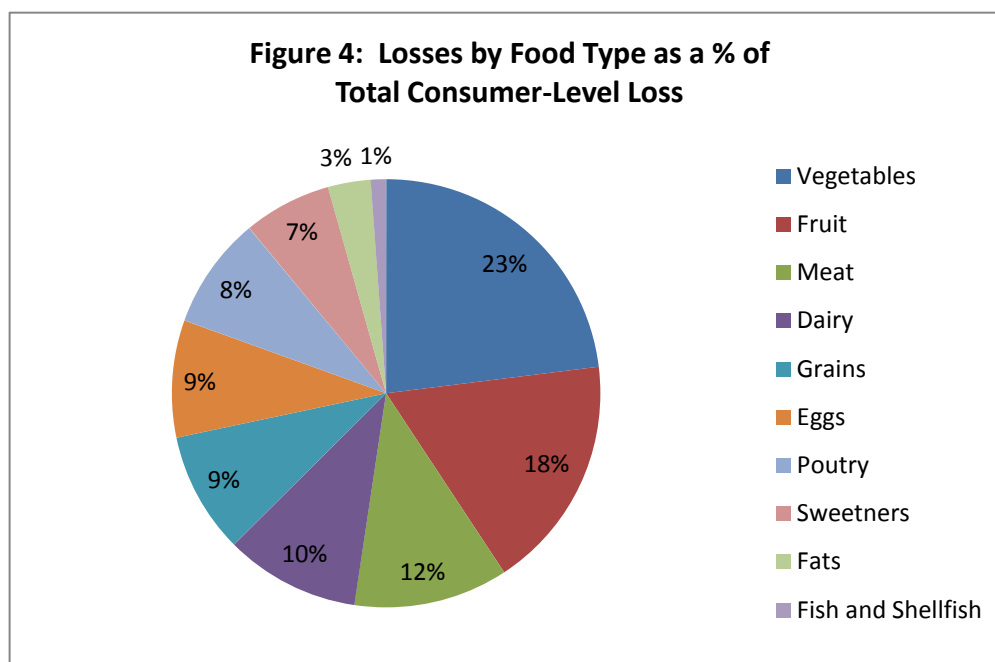
In terms of total loss, Figure 3 indicates that the annual per capita vegetable loss of 228 pounds is more than 2.5 times greater than that of the next largest annual per capita loss, red meat at 89 pounds.

Figure 3: Total Per Capita Losses and Per Capita Primary Weights by Food Group, 2008



Source: Economic Research Service, 2010 Loss-Adjusted Food Availability Spreadsheets

The proportionate loss volumes by food group are depicted in Figure 4 as percentages. Figure 4 shows the same total per capita loss as Figure 2 reapportioned as food type percentages.



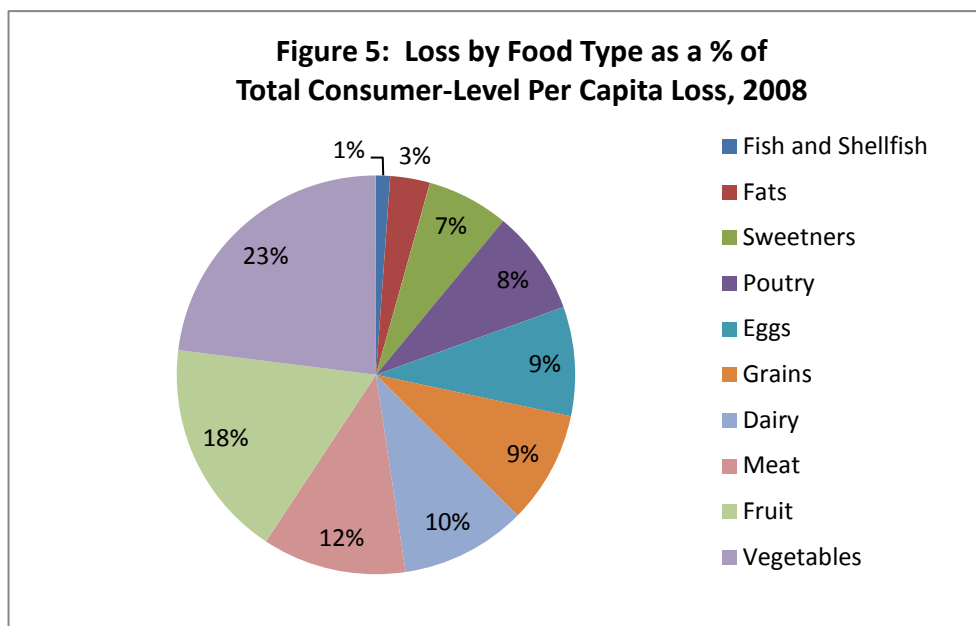
Source: Economic Research Service, 2010 Loss-Adjusted Food Availability Spreadsheets

Figure 4 indicates that fruit and vegetable losses together account for slightly more than half of total food losses (51 percent). Red meat and poultry also form a significant portion (29 percent) of total food loss. Dairy losses rank fifth at 5 percent of total food loss. In all, vegetables, meat, poultry, fruits, and dairy account for 86 percent of total food loss.

2.3.2 Per Capita Consumer-Level Loss Estimates by Food Type

While the per capita loss estimates by food type presented in Figures 3 and 4 above indicate the volume (by weight) impact of the various food types, it is also useful to have a picture of the per capita consumer-level losses. Per capita consumer-level losses represent the opportunities households have to reduce food waste at home.

Figure 5 shows the losses by food type as a percentage of total consumer-level per capita loss (47 percent of total per capita food losses in 2008 as shown in Figure 1). Vegetables and fruits are the first and second largest percentages of consumer-level food loss. Meat and dairy losses also represent a significant portion of household food loss.



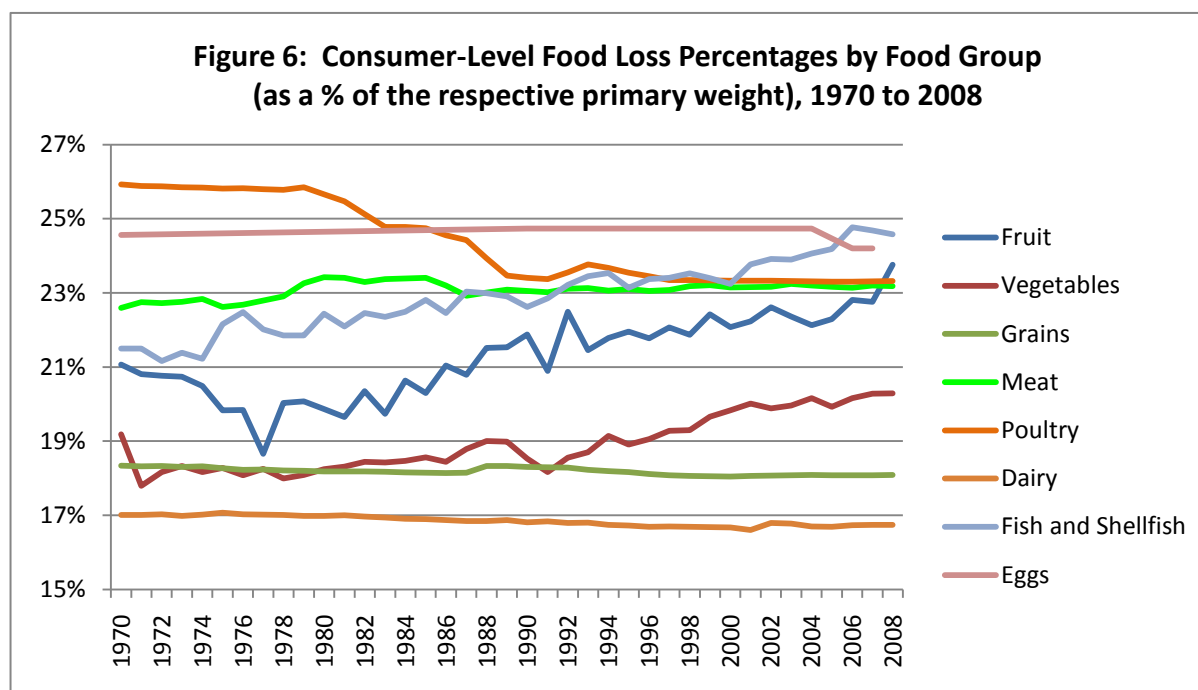
Source: Economic Research Service, 2010 Loss-Adjusted Food Availability Spreadsheets

The impacts of fruit and vegetables as a percentage of consumer-level losses are reflected in King County's organic waste (compost) data for 2009. Fruit and vegetable waste constituted 76 percent of the food waste portion.³⁸

While vegetable losses still comprise the largest fraction of the pie chart at 23 percent of the total loss, they constitute less of a percentage of consumer-level losses than they do of total losses (39 percent), that is, upstream losses (production and retail losses) for vegetables are proportionally greater than consumer-level losses. Meat also makes up a smaller fraction of consumer-level losses than of total losses but fruit, dairy, and grains are larger percentages of consumer-level losses than they are of total losses.

³⁸ "King County Solid Waste Division Organics Study Final Report." (Cascadia Consulting Group, 2009).

Figure 6 shows how losses by food type have varied over the past 4 decades.



Source: Economic Research Service, 2010 Loss-Adjusted Food Availability Spreadsheets

These variations primarily represent a change in the mix of food types (available to the consumer) within a given food group. Loss of a given food as a percentage of its primary weight is fixed in the ERS data tables. For example, there has been little change in the product presentation of eggs over the past 40 years as reflected in the nearly flat line for eggs in Figure 5. By contrast, poultry losses as a percentage of the primary per capita weight have dropped from 26 percent to 23 percent. The probable reason for this drop is an increase in the market share of deboned chicken parts.

The largest changes in consumer-level food loss by food type have been in the range of 4 percent. Fruit losses have risen from a low of less than 19 percent in 1977 to a high of almost 24 percent in 2008. This increase reflects a shift in the consumption of fruits to a greater share of out-of-season imported fruits. A similar rise is noted for vegetables.

2.3.3 Fruit and Vegetables

While fruit and vegetable waste figures predominately in both consumer-level and total food loss estimates, from the perspective of health and economic policy, it is the under-consumption of fresh fruits and vegetables that is considered urgent.³⁹ Only an estimated 27 percent of Americans eat close to the USDA-recommended 3 vegetable servings a day.⁴⁰ Diets that are high in fruits and vegetables are strongly associated with a decreased risk of obesity, such that increasing fruit and vegetable consumption is likely to stem the rise of obesity-related diseases, such as diabetes and heart disease, which are now at epidemic proportions.⁴¹

³⁹ Morgan, Emily, "Fruit and Vegetable Consumption and Waste in Australia." (2009).

<http://www.vichealth.vic.gov.au/~media/ResourceCentre/PublicationsandResources/healthyeating/FruitVegConsumptionWaste.ashx>.

⁴⁰ Center for Disease Control, "Fruit and Vegetable Consumption Among Adults --- United States, 2005." *MMWR Weekly*. 56 (10) pp. 213-217 (2007).

<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5610a2.htm>

⁴¹ Morgan, Emily, "Fruit and Vegetable Consumption and Waste in Australia." (2009).

<http://www.vichealth.vic.gov.au/~media/ResourceCentre/PublicationsandResources/healthyeating/FruitVegConsumptionWaste.ashx>.

Although Americans do not eat as many fruits and vegetables as recommended, produce consumption has increased over the past twenty-five years. On a farm-weight basis, the average American consumed 13 pounds more of commercially grown fresh fruit and 50 pounds more of fresh vegetables (excluding potatoes, sweet potatoes, and mushrooms) in 2003-05 than they did in 1985.⁴² Imports account for half of the growth in fruit consumption and one-fourth of the growth in vegetable consumption.

One reason for the significant amount of fruit and vegetable waste in household waste streams is their high perishability. In the U.K., 40 percent (by weight) of avoidable food waste is fruit and vegetables. Of that, almost 90 percent consists of fresh produce, most of which is thrown away as a result of not being used in time.⁴³ Morgan (2009) found that in Australia, the poor management of produce along the value chain means poor quality produce at the point of purchase.⁴⁴

The ERS data tables estimate a standard 20 percent loss for vegetables but their most recent research suggests that this is an underestimate.⁴⁵ One finding from this research is that foods used as garnishes and seasonings and seasonal foods (e.g., fresh pumpkins, fresh greens) have highest loss, but they also have the lowest consumption levels.

2.3.4 Meat and Dairy

American meat consumption has risen steadily since World War II, from around 138 pounds per person per year in 1955 to 185 pounds in 2008.⁴⁶ In comparison to the under-consumption of fruit and vegetables, Americans consume more meat than is considered healthy – the American Heart Association recommends 125 pounds per person per year.⁴⁷

Cheese consumption has more than doubled since 1975, but milk consumption has declined since its peak in 1945. Steep declines in the consumption of whole milk and buttermilk have outpaced increases in the consumption of lower fat milks. The decline in milk consumption is consistent with increasing health concerns about cholesterol and saturated fat. However, the decline may also be attributed to competition from other beverages (especially soft drinks and bottled water), a decrease in the percentage of children and youth in the population, and a more ethnically diverse population whose diet does not normally include milk.

Johnson, David et al., "Helping Consumers Reduce Fruit and Vegetable Waste: Final Report." (2008).

http://www.fcrn.org.uk/sites/default/files/Helping_consumers_reduce_waste_Final_report.pdf.

⁴² Huang, S., and K Huang, "U.S. Imports of Fresh Fruit and Vegetables." (USDA ERS Report, 2007).

⁴³ Johnson, David et al., "Helping Consumers Reduce Fruit and Vegetable Waste: Final Report." (2008).

http://www.fcrn.org.uk/sites/default/files/Helping_consumers_reduce_waste_Final_report.pdf.

⁴⁴ Morgan, Emily, "Fruit and Vegetable Consumption and Waste in Australia." (2009).

<http://www.vichealth.vic.gov.au/~media/ResourceCentre/PublicationsandResources/healthyeating/FruitVegConsumptionWaste.ashx>.

⁴⁵ Muth, Mary K. et al., "Consumer-Level Food Loss Estimates and Their Use in the ERS Loss-Adjusted Food Availability Data." (USDA ERS Report, 2011).

⁴⁶ Corum, Jonathan, "A Century of Meat". Graphic: The New York Times (March, 15 2011).

⁴⁷ Hamerschlag, Keri, "Meat Eater's Guide to Climate Change and Health." Report for the Environmental Working Group (2011).

<http://www.ewg.org/meateatersguide/>

2.4 WASTE ESTIMATES BY DEMOGRAPHICS AND MARKET SEGMENTS

The question of who wastes food – or more precisely, who thinks they waste food – is one on which there has been little research. This section of the report summarizes the research findings regarding the relative amounts of waste by demographics and market segments.

Observed differences in amounts wasted can be attributed to the following socio-demographic factors.⁴⁸

- Age: Younger people (less than 45 years) tend to waste more than older people and retirees.
- Age of children: Households with younger children report greater amounts of waste.
- Gender: Females tend to waste more than males.
- Employment: People in full time work are more likely to waste greater amounts.
- Income: Higher income individuals waste more than lower income individuals.
- Size of household: Larger households waste more than smaller households but waste less per household member.

Less food waste is typically found in rural waste streams, in part because there are more options for disposing waste, such as feeding leftovers to animals.⁴⁹

An Austrian study found that people older than 50 years tend to throw away less food than younger age groups.⁵⁰ This was attributed to older persons' "war mentality" (experience of times of extreme food shortage), lower incomes, and more available time (for a related discussion, see Section 3.2). Younger professionals eat out more frequently which, in turn, is likely to influence their shopping, storage management, and preparation behaviors.⁵¹

While the Austrian studies indicate that more highly educated and higher income people throw away more food, a WRAP survey found that people of lower social class (i.e., those with less income and education) were more likely to think of themselves as wasting more.⁵² This discrepancy might be explained by the self-classification scheme used in the WRAP survey: lower income households may be more sensitive to food waste and thus more likely to report that they wasted "quite a lot" or "a reasonable amount", the answers used in the WRAP survey to classify high food wasters. The impact of income on food waste behaviors needs more research to determine the direction of influence.

⁴⁸ Friedl, B., and Ines Omann, "Socio-economic Drivers of (Non-) Sustainable Food Consumption." Paper for the Conference of the Sustainable Consumption (2005).

http://www.old.seri.at/documentupload/isee_friedl-omann-pack_paper_final.pdf.

Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

Schneider, F, "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>.

⁴⁹ Schneider, F, "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

⁵⁰ Schneider, F, "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

⁵¹ Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>

⁵² Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009).

Schneider, F, "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

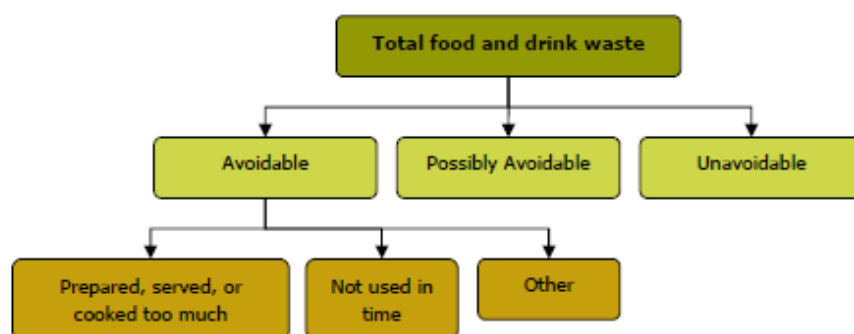
2.5 WASTE ESTIMATES BY TYPE OF FOOD WASTE

Consumer-level food waste estimates combine both the edible and non-edible portions of food waste (see Section 2.1). The edible portion can be further disaggregated into food that was purchased but never used, food used in the preparation process (e.g., frying fats), and food that was prepared or served but not eaten. The non-edible portion can also be further divided into food waste that is unavoidable and waste that is possibly avoidable, such as potato peels and beet greens. ‘Plate waste’ and ‘leftovers’ are terms used to designate prepared or served food that was not eaten, although leftovers may be consumed at a later meal.

WRAP has developed a useful classification scheme of avoidable food and drink waste (i.e., potentially edible food) based on two reasons for disposal – ‘prepared, served, and cooked too much’ and ‘not used in time’ – that is shown in Figure 7.

WRAP found that just over half of avoidable waste in the U.K. was ‘not used in time’ and another 40 percent fell into the category of ‘prepared, served, or cooked too much.’⁵³ However, a large variation in classification by food type was observed. For example, three fourths of drink waste was categorized as ‘prepared, served, and cooked too much’, probably reflecting the long shelf-life of drink items. In comparison, 61 percent of avoidable food waste was food that was not used in time.

Figure 7: Classification of Food and Drink Waste Types



Source: Household Food and Drink Waste in the UK (Quested and Johnson, 2009)

Two important types of not-used-in-time waste are original food and partially used food. Original food refers to either food that is discarded in unopened packaging or food that is sold loosely that is not used at all (e.g., unpackaged fruits and vegetables). Examples of original food include yogurt and packaged lunch meat. Examples of partially used food waste are a discarded box of stale crackers, half a loaf of bread, and limp celery stalks.

In WRAP’s study, the most common reason for household food waste is that it is left unused.⁵⁴ 61 percent of avoidable food waste falls into this category and of that, 40 percent isn’t even touched and a tenth is still ‘in date’. However, in an earlier WRAP survey of food waste behaviors, households reported that they wasted more prepared food and partially opened food than original food, with the exception being fruits and vegetables which were cited as a significant source of waste.⁵⁵

A comparative waste characterization study of two different Austrian regions found that, in one region, inedibles comprised 32 percent of household food discards, while original and partially used food waste

⁵³ Quested, Tom, and H. Johnson, “Household Food and Drink Waste in the UK.” (WRAP Report, 2009).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>

⁵⁴ Quested, Tom, and H. Johnson, “Household Food and Drink Waste in the UK.” (WRAP Report, 2009).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>

⁵⁵ Cox, Jayne, and Phil Downing, “Food Behaviour Consumer Research: Quantitative Phase.” (WRAP Report, 2007).

separately accounted for 24 percent to 25 percent each. The remainder was plate waste. In the second region, the original and partially used food wastes equaled 15 percent and 32 percent respectively and discarded leftovers were another 19 percent. In sum, nearly two-thirds of Austrian household food waste could theoretically have been eaten given different consumption choices.⁵⁶ The Austrian analysis showed a significant positive correlation of a high amount of original food and a high proportion of persons aged between 20 and 59. Higher levels of education and full-time employment correlated with increased food waste.⁵⁷

2.6 ENVIRONMENTAL IMPACTS OF FOOD WASTE

The largest environmental impact of food consumption is indirect as it is incurred upstream of household consumption during production, processing, and distribution.⁵⁸ At the same time, the direct impacts of food and drink consumption (e.g., household food waste, energy used in post-retail, consumer transport and storage) are trending upwards.

Recently, there have been a number of studies estimating the carbon footprint of food waste, but food waste also results in significant impacts with respect to other environmental challenges.⁵⁹ For example, Hall and others (2009) have estimated that food waste accounts for one-fourth of fresh water consumption in the U.S.⁶⁰

Generally, the method used to estimate and compare impacts by type is to develop and apply impact factors to current levels of total consumption or the waste fraction of consumption. As it is beyond the scope of this research to independently calculate the environmental impacts of food waste, we review the findings from other studies to establish plausible estimates of impact.

2.6.1 Gross Impacts

A 2003 Swedish study on the carbon impacts of diet found that the energy life cycle inputs of different diets with a similar number of calories can vary as much as by a factor of four, from 6,900 up to 21,000 mega joules per person per year.⁶¹ A Finnish study that used materials intensity per unit (MIPS) methodology to measure impact of household consumption found that the impact from food consumption varied by a factor of three according to variations in diet.⁶²

⁵⁶ Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

Quested, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009).

Schneider, F., "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

⁵⁷ Schneider, F., "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

⁵⁸ Owen, L. et al., "Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs." (2007).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Public+Understanding+of+Sustainable+Consumption+of+Food#0>.

⁵⁹ See, for example, Brodt et al. (2008), Garnett (2008), and Lee et al. (2010).

⁶⁰ Hall, Kevin D. et al., "The Progressive Increase of Food Waste in America and Its Environmental Impact." *PLoS ONE* 4, no. 11 (2009).

⁶¹ Carlsson-Kanyama, Annika et al., "Food and Life Cycle Energy Inputs: Consequences of Diet and Ways to Increase Efficiency." *Ecological Economics* 44, no. 2-3 pp. 293-307 (March, 2003).

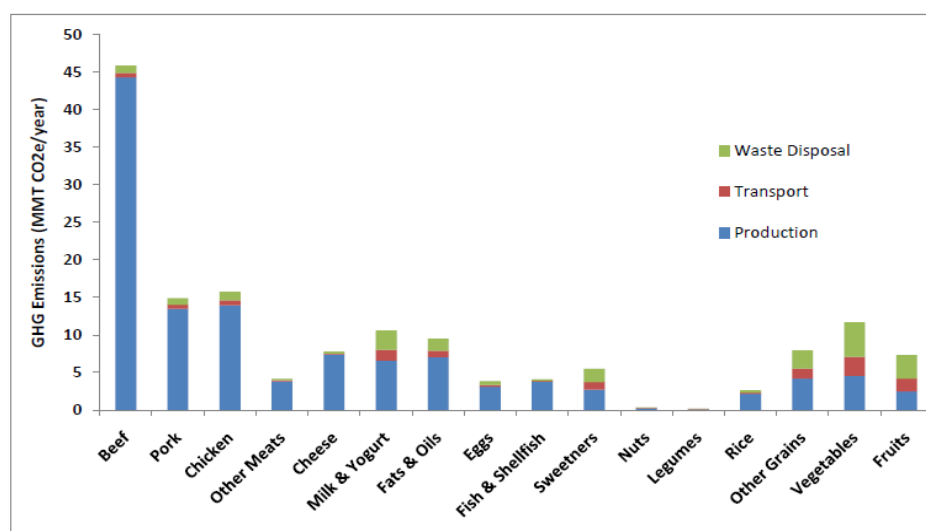
<http://linkinghub.elsevier.com/retrieve/pii/S0921800902002616>.

⁶² Kotakorpi, Satu et al., "Household MIPS: Natural Resource Consumption of Finnish Households and Its Reduction." (2008).

2.6.2 Impacts by Food Type

Venkat (2011) used ERS food loss estimates at the retail and consumer levels and a proprietary model to analyze the greenhouse gas (GHG) emissions from producing, transporting and landfilling the wasted food (ignoring impacts prior to the retail stage) for selected foods.⁶³ The results are shown in Figure 8.

Figure 8: Retail and Consumer-Level GHG Emission Impacts by Food Type



Source: The Climate Change Impact of U.S. Food Waste (Venkat, 2011)

The GHG impact of beef waste is nearly 4 times greater than vegetable waste and 7 times greater than fruit waste. The combined impact for all meat waste is 4.5 times greater than the combined impact of fruit and vegetable waste.

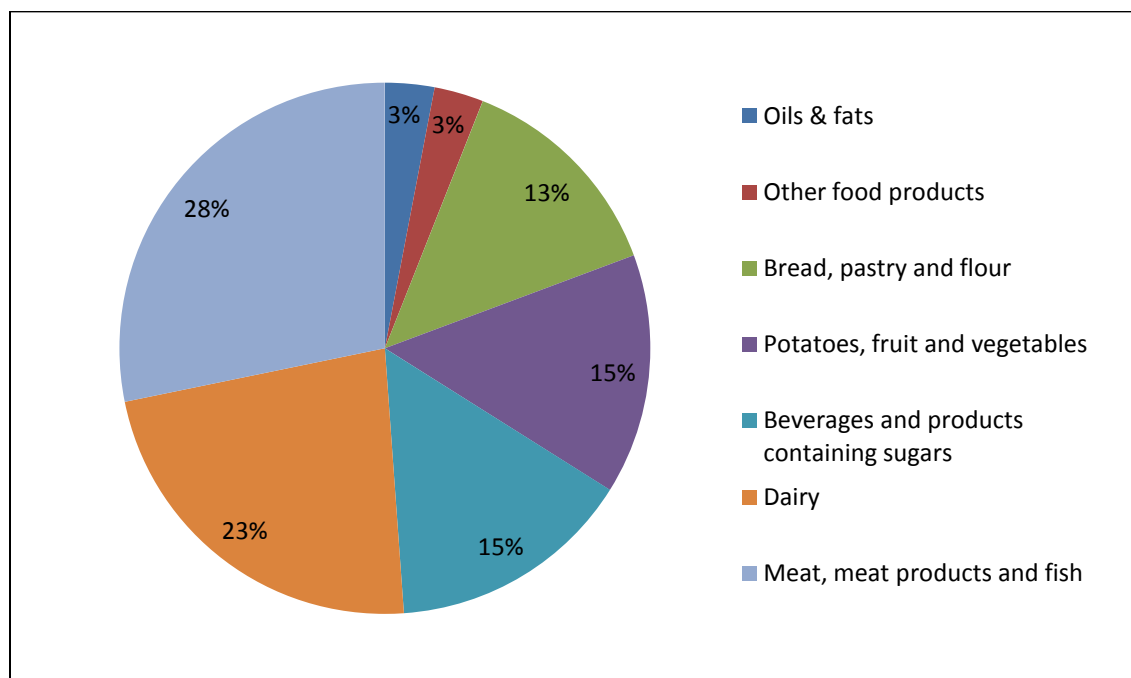
However, looking at the tail end of the life cycle, a subsequent report using the same model to estimate emissions found that the methane produced during waste decomposition accounts for a small portion of emissions from meat and a larger portion of emissions from plant food.⁶⁴

⁶³ Venkat, Kumar. "The Climate Change Impact of U.S. Food Waste" Report. (2011).
<http://www.cleanmetrics.com/pages/ClimateChangeImpactofUSFoodWaste.pdf>

⁶⁴ Hamerschlag, Keri, "Meat Eater's Guide to Climate Change and Health." Report for the Environmental Working Group (2011).
<http://www.ewg.org/meateatersguide/>

Figure 9 shows the results from a Dutch study which found that meat and dairy consumption (as opposed to waste) contributes over half of GHG emissions in the Netherlands and that dairy consumption was nearly equal in impact to that of meat.⁶⁵ The combined impact of meat and dairy consumption was 3.4 times that of fruit and vegetables.

Figure 9: Contribution of Food Groups to Dutch GHG emissions



Source: Food and Climate Change: The World on a Plate (Garnett, 2009)

2.6.3 Factors in Food System GHG Emissions

From a systems standpoint, changing food consumption patterns to substitute less-resource intensive foods for those with high environmental impacts may be more effective than targeting certain food groups for elimination. Targeting high-impact consumption behaviors may also be more effective.

Brodt and others (2008) found six major factors in high energy use and GHG emissions in the U.S. food system.⁶⁶

- Livestock-related methane and nitrous-oxide emissions
- Synthetic nitrogen fertilizers
- Air freight
- Heated greenhouse production
- Post-retail consumer transport and storage
- Food waste at multiple points along the supply chain

⁶⁵ Garnett, Tara, "Cooking up a Storm: Food, Greenhouse Gas Emissions and Our Changing Climate." (2008). http://www.fcm.org.uk/sites/default/files/CuaS_web.pdf.

⁶⁶ Brodt, Sonja, et al., "The Low-Carbon Diet Initiative" Working paper. (2008). <http://woodland.ca.lvnnet.org/files/WhitePaperOnEnergyUseAndGreenhouseGasEmissionsInTheFoodSystem.pdf>

These factors suggest other means of reducing GHG emissions in addition to reducing food waste, such as: increasing organic fruit and vegetable consumption (synthetic nitrogen fertilizers); eating more seasonally (air freight and heated greenhouse production), and changing where and when to shop to reduce GHG emissions associated with consumer transport.

2.7 CONCLUSIONS ON OPPORTUNITIES TO REDUCE FOOD WASTE

Based on the analysis and data presented above, the major opportunities to reduce the amounts of food waste and the impacts of food waste are as follows:

- **Focus on Fresh Fruit and Vegetable Waste:** Fruit and vegetable waste is the largest portion of the solid food waste stream, accounting for slightly over half of total food waste and 41 percent of consumer-level losses in 2008. In addition, a significant portion of the environmental impact of fruit and vegetable waste occurs during the waste decomposition process. Moreover, the trend is towards greater consumption of fruit and vegetables for health reasons, as well as a shift to fresh fruit and vegetable consumption in preference to eating canned and frozen fruits and vegetables. This is likely to result in more household fruit and vegetable waste in the short term. A focus on fresh fruits and vegetable waste could improve household economics and counter the trend towards greater waste.
- **Focus on Young Full-Time Workers and Families with Young Children:** Young full-time workers and families with young children have been identified in a number of consumer behavior studies as wasting more than other market/demographic segments.
- **Distinguish between Foods That are 'Not Used in Time' and Foods That Are Wasted because 'Too Much Was Bought, Cooked, Prepared, or Served':** For highly perishable foods, the emphasis should be on extending shelf life, using the foods before they go to waste, and freezing perishables for later use. For foods with longer shelf lives, the emphasis should be on buying less.
- **Focus on High-Impact Foods:** Although meat and dairy only comprises 22 percent of consumer-level food loss by weight, they have the largest indirect impacts on resource consumption of all the major food groups. Shifting behaviors associated with meat and dairy consumption will be challenging. At the same time, consumption impact studies have found that typical diet alternatives within a country vary as much as a factor of 3 or 4 suggesting change is already happening. A key strategy will be to expand choices for consumers by offering low-impact substitutes.

3.0 OPPORTUNITIES FOR CHANGE

Understanding household choices that influence purchasing, storing, preparing, serving, and disposing food is key to reducing household food waste.

The objective of the literature review summarized in this section is to identify which behaviors present potential opportunities to significantly reduce the environmental impacts of food waste and what are the barriers and benefits to those behaviors.

3.1 SOURCES OF CONSUMER LEVEL WASTE

The reasons for consumer-level food loss vary greatly among individual foods. According to the USDA, the major sources of food waste are⁶⁷:

- Inedible share (e.g., apples cores and chicken bones)
- Cooking and preparation discards (e.g., frying fats)
- Discards due to expired use-by or open dates
- Discards due to over-preparation of foods (leftovers) and plate waste
- Spoilage

These product conditions describe the proximate causes for food discards but do not explain the consumer behaviors underlying food waste. These are discussed below.

3.2 BEHAVIOR-INFLUENCING FACTORS

Recent research into consumption and food waste behaviors reveal a complex terrain of behavior-influencing factors. These include perceptions, habits, lifestyles, economic and technological motivators, and social norms. It should be noted that disentangling the various behavior-influencing factors to determine the root causes of food waste is beyond the scope of this work. The literature primarily focuses on the relationship of personal choice to food waste. Less information has been collected on lifestyle influences and economic and technological motivators, although some longer term trends are evident. For example, Americans spend a smaller share of their disposable income on food than people elsewhere.⁶⁸ In consequence, the associated abundance of product choices and cheap products is thought to encourage waste.⁶⁹ The findings reported below should be understood to point to possible outcomes of efforts to reduce wasteful consumption, not as confirmation of those behaviors. Many of the empirical studies were conducted in Europe with small sample populations. Other influences may be at play in the U.S., given the different historical, social, demographic, and market influences.

Another caveat in drawing conclusions from the literature findings is that much of the research on consumer behaviors relies on self-reporting. It should be understood that what consumers self-report is to be taken as perception, not fact. One notable observation of consumer perception of food waste is that many study participants, especially older ones, initially reject the idea they waste food.⁷⁰

⁶⁷ Muth, Mary et al., "Exploratory Research on Estimation of Consumer-Level Food Loss Conversion Factors." (USDA ERS Report, 2007).

⁶⁸ Kantor, Linda Scott et al., "Estimating and Addressing America's Food Losses. Food Review." (1997).

<http://www.ers.usda.gov/Publications/FoodReview/Jan1997/Jan97a.pdf>.

⁶⁹ Bloom, Jonathon, "American Wasteland: How America Throws Away Nearly Half Its Food and What We Can Do About It." (Da Capo Lifelong Books, 2010).

⁷⁰ Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

Nevertheless, perception plays an important role in decision-making and thus provides useful guidance for developing community-based social marketing campaigns. Researchers also take steps to design their studies to counter the biases in self-reporting.

3.3 CONSUMER WASTE BEHAVIORS

Table 2 summarizes the literature on consumer waste behaviors. The behaviors are grouped according to four consumption stages: shopping, storage, preparation, and eating. This is similar to other behavior classifications.⁷¹

Influencing factors are identified as potential benefits and barriers to individuals changing their behavior. Significant observations, as reported in the literature, are discussed in greater detail in the narrative below.

Major sources for the information included in Table 2 are the WRAP reports on household waste and food management behaviors; two Austrian studies; and a series of studies performed at Cornell University's Food and Brand Lab.⁷²

3.3.1 Shopping Behaviors

For most people, shopping is a routine.⁷³ People like to shop at the same store or stores where they are familiar with the layout and product choices and don't have to think too much about what to buy. The significance of routines in designing behavioral interventions is that it is harder to change routine habits, such as food shopping, than it is to influence one-off behaviors, such as purchase of a new refrigerator.⁷⁴ Food shopping is also a complex process involving many influencing factors, including cost, convenience, health, habit, taste, product availability, and more.⁷⁵ Consumers often have contradictory goals shaped by three key drivers: health, quality, and gratification. Affordability is also a prime consideration. Many shoppers are not likely to think about sustainable consumption. However, some health conscious choices lead to sustainable choices such as purchasing organic produce or eating locally.

Over-purchasing appears to be a major set of behaviors underlying household food waste: products spoil or reach their "use by" dates before they are – or can be – eaten. Research into how consumers decide how much to purchase suggests that they develop internal anchors based on past usage (how much do I use routinely), intended future usage (how much do I think I can use), and their average

⁷¹ *ibid*

⁷² Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

Falcon, Julia et al., "Love Food Champions." (WRAP Report, 2008). http://www.wrap.org.uk/downloads/LFC_draft_FINAL_report_171008-FINAL.09ab9907.6083.pdf

Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

Wansink, Brian, "How Resourceful Consumers Identify New Uses for Old Products." *Journal of Family and Consumer Sciences*. (2003).

http://foodpsychology.cornell.edu/pdf/permission/2003/Resourcesful_Consumers-JFCS-2003.pdf.

Wansink, Brian, "Environmental Factors that Increase the Food Intake and Consumption Volume of Unknowing Consumers." *Annual review of nutrition* 24, no. 217 (January) pp. 455-79 (2004).

<http://www.ncbi.nlm.nih.gov/pubmed/15189128>.

Wansink, Brian, "Abandoned Products and Consumer Waste: How Did That Product Get into the Pantry?" *Choices: The Magazine of Food, Farm and Resource Issues* (2001).

<http://elibrary.ru/item.asp?id=4141526>.

⁷³ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁷⁴ Jackson, Tim, "Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change." (2005).

<http://www.comminit.com/en/node/219688/306>.

Thaler, R H, and C R Sunstein, "Nudge: Improving Decisions about Health, Wealth, and Happiness." (Yale University Press, 2008).

⁷⁵ Owen, Liz et al., "Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs." (2007).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Public+Understanding+of+Sustainable+Consumption+of+Food#0>.

inventory.⁷⁶ Whether consumers are overstock-adverse or shortage-adverse affects their inventory estimates.⁷⁷ Younger consumers are more likely to buy too much, perhaps because their ideas about how much they use are still forming.⁷⁸

When asked, consumers frequently state that marketing promotions (e.g., “two for the price of one”) and discounts are a large influence in over-purchase.⁷⁹ Yet a Cornell study that focused on why consumers had not used products found in their pantries that were purchased more than six months earlier revealed that most abandoned products were ones bought for a specific use, such as a special occasion or the making of a particular recipe that did not happen.⁸⁰ Glanz (2008) observed that seasonal products and products bought to prepare special recipes are frequently only partially used.⁸¹

⁷⁶ Wansink, Brian et al., “An Anchoring and Adjustment Model of Purchase Quantity Decisions.” *Journal of Marketing Research* 35, no. 1 pp. 71–81 (1998).

<http://www.jstor.org/stable/3151931>.

Chandon, Pierre, and Brian Wansink, “How Biased Household Inventory Estimates Distort Shopping and Storage Decisions.” *Journal of Marketing* 70, no. October pp. 118–135 (2006).

⁷⁷ Chandon, Pierre, and Brian Wansink, “How Biased Household Inventory Estimates Distort Shopping and Storage Decisions.” *Journal of Marketing* 70, no. October pp. 118–135 (2006).

⁷⁸ Cox, Jayne, and Phil Downing, “Food Behaviour Consumer Research: Quantitative Phase.” (WRAP Report, 2007).

⁷⁹ Cox, Jayne, and Phil Downing, “Food Behaviour Consumer Research: Quantitative Phase.” (WRAP Report, 2007).

Owen, Liz et al., “Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs.” (2007).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Public+Understanding+of+Sustainable+Consumption+of+Food#0>.

Glanz, Robert, “Causes of Food Waste Generation in Households – An Empirical Analysis.” *Applied Sciences* (2008).

⁸⁰ Wansink, Brian et al., “The Mystery of the Cabinet Castaway: Why We Buy Products We Never Use.” *Journal of Family and Consumer Sciences* no.92 (1) pp. 104 (2000).

Wansink, Brian, “Abandoned Products and Consumer Waste: How Did That Product Get into the Pantry?” *Choices: The Magazine of Food, Farm and Resource Issues* (2001).

⁸¹ Glanz, Robert, “Causes of Food Waste Generation in Households – An Empirical Analysis.” *Applied Sciences* (2008).

Table 2: Summary of Consumption and Waste Behavior-Influencing Factors

Phase	Behavior/Choice	General Impact on Waste	Influencing Factors (Potential Barriers and Benefits)
Shopping	Pre-Shop Planning	Meal planning and shopping lists based on storage inventory reduce waste	Time availability; age; income
	Frequency of Shopping	More frequent shopping is associated with less waste	Age; shopping location; time availability
	Shopping Venue	Where people shop can affect which types of products are bought and amounts purchased	Time availability; convenience (hours and location); product availability and variety; product freshness and quality; size of store; mode of transportation; store facilities such as parking; in-store promotions and marketing
	Amounts Purchased	Over-purchasing leads to more waste	Time availability; frequency of shopping; where one shops; income; age; household size and composition; amount of storage space; mode of transportation; produce lot or package size; marketing promotions; price
	Items Purchased	Waste behaviors vary for different food types	Income; presence of children while shopping; health focus; consumer preferences; product availability
Storage	Inventory Amounts	Larger inventory associated with greater waste	Amount of storage space; preservation (canning, freezing, drying) skills; available time
	Storage Management	Storage management skills lowers the amount of waste	Storage skills; available time; frequency of storage cleaning
	Storage Location	Where products are stored can affect spoilage	Product shelf life; amount of storage space of different types
Preparation	Frequency of Preparation	More frequent preparation leads to faster turnover of stock and less waste	Time availability; frequency of meals outside home; family values; product substitution knowledge; freshness dating; product shelf life; cooking knowledge and skills
	Amounts Prepared	Cooking and preparing too much food is associated with more waste	Size of family; recipe portions; cooking and preparation skills
	Items Used	Preferences for eating some foods before others leads to waste	Time availability; product substitution knowledge; cooking and preparation skills; food preferences; convenience
Eating	When to Eat Items	Not eating foods before they go to waste is a major cause of avoidable food waste	Time availability; product freshness and quality; food preferences; age; household composition and size; habit
	Serving Size	Serving too much food is associated with more waste	Environmental factors; social norms; habit; health concerns
	Items Eaten	Preferences for eating some foods before others leads to waste	Time availability; product freshness and quality; food preferences; cost; habit; health concerns; convenience

Pricing biases towards large package sizes and not being able to purchase smaller amounts, due to standard lot/bunch/package sizes have also been found to contribute to over-purchasing.⁸² This is especially an issue for single person households. A WRAP study of portion sizes found that a third of shoppers had an issue with standard purchase sizes with smaller households registering their dissatisfaction more often.⁸³ Shoppers like a deal and might be led to buy reduced-price items that are less fresh or are close to expiration dates. People are less likely to fall for a promotion if they use shopping lists or check their stocks before leaving home.⁸⁴

The frequency of one's shopping also affects the amounts purchased. In turn, frequency is influenced by where one shops and the time allotted for shopping. Car owners typically shop less frequently and buy more. More trips are generally associated with purchase of what is immediately needed which results in less waste but frequent shoppers are more likely to make spontaneous purchases which can lead to more waste.⁸⁵ There is less need for a shopping list or meal planning if consumers are shopping for short-term needs.

U.K. consumers cite their intent to buy more fresh produce as a major reason for food waste.⁸⁶ However, the perceived costs of organic and local foods are a barrier to purchasing more.⁸⁷

Many people choose the location of where they shop based on what products the store carries, prices, and product quality. In focus groups of U.K. shoppers, some younger consumers stated they used internet shopping because of better product availability and because they saw it as a way of reducing unintended purchases.⁸⁸

In a survey of U.S. consumers, it was found that an increasing percentage of consumers routinely buy locally grown produce, citing freshness, taste, and quality as incentives.⁸⁹ However, 60 percent of the survey's respondents indicated that they were unwilling to pay a price premium for produce that contributes 50 percent fewer greenhouse gas emissions.

Pre-shop planning and shopping lists are major tools in managing household consumption. Planning helps to reduce waste by limiting over-purchase. Shopping lists are used by a majority of people in the U.K., but less than 50 percent stick to those lists as they are merely seen as reminders and not as definite lists.⁹⁰ A recent consumer survey of U.S. shoppers, reported in the Wall Street Journal, found that two-thirds of shoppers now use lists to save money and many are adopting new technologies, such as phone applications, as shopping tools. Other phone applications to address waste have also been developed, such as one that suggests recipes based on what food items you have on-hand at home.

⁸² Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

⁸³ Lyndhurst, Brook, "Research into Consumer Behaviour in Relation to Food Dates and Portion Sizes." (October, 2008).

Lyndhurst, Brook and ESA, "Helping Consumers Reduce Food Waste – A Retail Survey." (WRAP Report, 2010).

⁸⁴ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁸⁵ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁸⁶ Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

⁸⁷ Owen, Liz et al., "Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs." (2007).

⁸⁸ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁸⁹ Pirog, Rich, and Rebecca Rasmussen, "Food, Fuel and the Future: Consumer Perceptions of Local Food, Food Safety and Climate Change in the Context of Rising Prices." (2008).

<http://www.leopold.iastate.edu/pubs/staff/consumer2/consumer2.pdf>.

⁹⁰ "Love Food Hate Waste." (WRAP, 2007).

<http://www.lovefoodhatewaste.com>

Older and lower income persons are least likely to be impulse buyers preferring to stick to brands they know.⁹¹ The presence of children on shopping trips often leads to the purchase of unplanned items.

Items that are frequently purchased (e.g., sandwich bread) are less likely to be wasted than specialty items (e.g., hot dog buns). Households that buy the same items routinely or are loyal to brands waste less. Conversely, people who like to try out new foods are more likely to waste food.⁹² Rathje and Murphy (1992) also found that household waste is generally lower for frequently purchased staple items like bread, milk, and cereal, than for less frequently used specialty products such as hot dog buns or items bought on impulse.⁹³

Convenience and time availability have a huge influence on shopping habits and thus indirectly on waste behaviors. Consumers are more interested in minimizing shopping costs (i.e., time spent) than maximizing returns (i.e., saving dollars).⁹⁴ Time pressures usually lower home consumption amounts and the probability of trying new products.⁹⁵

3.3.2 Storage

Storage knowledge and skills can prevent food waste by informing choices on inventory amounts, where to store items, and when to use perishables. Consumers make decisions about inventory stock and where to store items based on their knowledge of products' shelf-lives, their available storage space, and the time and skills they have to prepare items for storage. The WRAP household waste behaviors survey found that older consumers were more likely to organize their storage space.⁹⁶

Taking time to organize storage during restocking can prevent waste. Routinely rotating items in storage reminds consumers to use more dated items. Conversely, WRAP survey participants stated that sporadic cleaning of storage (e.g., spring cleaning) often resulted in items being tossed out.

Adding new items to the front or top of the refrigerator or freezer keeps older items out of sight and mind. Food (especially meat) stored too long in the freezer is wasted because of freezer burn. Storing items in unexpected places, such as jam in a drawer, can cause people to forget about them.⁹⁷

Storage conditions, such as humidity, light, and temperature affect shelf-life. The shelf-life of most fresh fruits and vegetables can be prolonged through refrigeration, but consumers could use more information about which fruits and vegetables to store where to keep them fresh. Experimental testing of fruit and vegetable storage by WRAP revealed that 13 of 16 produce types keep longer if stored in the refrigerator.⁹⁸ For example, peppers, carrots and tomatoes will last a week longer if stored in the refrigerator.

Few U.S. consumers have food preservation skills and could benefit from workshops on preserving techniques.⁹⁹ The use of airtight containers in extending produce life is also not prevalent. Single people are less concerned about lengthening the shelf life of their food.¹⁰⁰

⁹¹ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁹² Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

⁹³ Rathje, William et al., "Rubbish! The Archeology of Garbage". University of Arizona Press.(1992).

⁹⁴ Wansink, Brian et al., "An Anchoring and Adjustment Model of Purchase Quantity Decisions." *Journal of Marketing Research* 35, no. 1 pp. 71–81 (1998).

<http://www.jstor.org/stable/3151931>.

⁹⁵ Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

⁹⁶ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

⁹⁷ Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

⁹⁸ Johnson, David et al., "Helping Consumers Reduce Fruit and Vegetable Waste: Final Report." (2008).

http://www.fcm.org.uk/sites/default/files/Helping_consumers_reduce_waste_Final_report.pdf.

⁹⁹ National Center for Home Food Preservation, 2002; Portland Bureau of Planning and Sustainability, 2011

3.3.3 Preparation

The significant amount of plate waste and leftovers that are thrown away is likely an indication of poor cooking and preparation skills. The WRAP survey of consumer behaviors found that food that was burnt or ruined during preparation was a significant source of waste among young consumers.¹⁰¹ Learning proper portioning (e.g. knowing how much rice or pasta to cook) also helps to reduce waste of the preparing-too-much type.¹⁰²

The choice of how much to cook for a given meal is influenced by habit and purchase packaging size but also societal norms. A recent study showed that recipe serving sizes and caloric levels increased gradually with each of seven editions of *The Joy of Cooking*.¹⁰³

Skilled cooks can easily substitute different ingredients for those listed in the recipes they might use and are also knowledgeable about combining different ingredients enabling them to make use of what is already at hand. Wansink (2003) in a Cornell University Food and Brand Lab study found that the leading motivators for substituting one food product for another were health and time – not money.¹⁰⁴

Not surprisingly, households that cook from scratch (i.e., with fresh ingredients) produce higher amounts of inedible food waste. Personal lifestyle influences the meal preparation frequency and the amount of time spent planning or preparing dishes.¹⁰⁵ More waste occurs in households where the persons do not often eat in and cooking is unusual.¹⁰⁶ Many consumers, especially those working full time, favor the convenience of prepared foods and meals.¹⁰⁷

3.3.4 Eating

Eating is an activity that is fraught with social meaning.¹⁰⁸ Research indicates that adopting a low-impact diet is unpopular with most people and reducing dairy consumption is even less popular than eating less meat.¹⁰⁹

A large amount of avoidable food waste is associated with not eating foods that need to be eaten first. Glanz (2008) found that if food was thought not to be fresh or tasty, it was likely to get overlooked for fresher products (e.g., new loaf of bread) which were eaten first, causing older ones to spoil.¹¹⁰

For food groups with relatively short shelf lives, the majority of waste arises because the food was 'not used in time.'¹¹¹ At the other end of the scale are prepared meals and beverages: in U.K. households, over 60 percent of the avoidable waste for these food types occurs from cooking, preparing, or serving too much food.

¹⁰⁰ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

¹⁰¹ Corrado, Michele, "Understanding Consumer Food Management Behaviour." (WRAP Report, 2007).

http://www.wrap.org.uk/downloads/Understanding_consumer_food_management_behaviour_jly_2007.0480a34c.6395.pdf.

¹⁰² Falcon, Julia et al., "Love Food Champions." (WRAP Report, 2008). http://www.wrap.org.uk/downloads/LFC_draft_FINAL_report_171008-FINAL.09ab9907.6083.pdf

¹⁰³ Wansink, Brian, and Collin Payne, "The Joy of Cooking Too Much." *Annals of Internal Medicine*, no. 150 pp. 291 (2011).

<http://foodpsychology.cornell.edu/outreach/joy-of-cooking.html>.

¹⁰⁴ Wansink, Brian. "How Resourceful Consumers Identify New Uses for Old Products." *Journal of Family and Consumer Science*. (2003).

¹⁰⁵ Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

¹⁰⁶ Schneider, F, "Wasting Food – An Insistent Behaviour." Paper for Waste - The Social Context '08: Urban Issues and Solutions (2008).

¹⁰⁷ Owen, Liz et al., "Public Understanding of Sustainable Consumption of Food: A Report to the Department for Environment, Food and Rural Affairs." (2007).

¹⁰⁸ Garnett, Tara, "Cooking up a Storm: Food, Greenhouse Gas Emissions and Our Changing Climate." (2008).

http://www.fcni.org.uk/sites/default/files/CuaS_web.pdf.

¹⁰⁹ Power, Kate, "Introducing Behaviour Changes towards Sustainable Food Consumption." (2010).

¹¹⁰ Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

¹¹¹ Quesada, Tom, and H. Johnson, "Household Food and Drink Waste in the UK." (WRAP Report, 2009).

<http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Household+Food+and+Drink+Waste+in+the+UK#0>.

In the case of fruits and vegetables spoilage, the problem appears to not be so much over-purchase as under-consumption. The paradox of high waste and low consumption of fruit and vegetables might be attributable to their low valuation by consumers.¹¹² There is evidence that consumers are becoming more motivated to eat fresh products, especially fruits and vegetables, for health reasons but their limited shelf life leads to spoiling before consumers get around to eating them.

Seasonality affects how quickly produce spoils. Many shoppers aren't knowledgeable about what fresh products are available when as they are used to buying seasonal items year round as imports.

Freshness dating on packaged goods (e.g., bread, yogurt) affects perceptions of healthfulness and freshness leading people to discard products that are still edible.¹¹³ Research shows that people's perceptions of how fresh a product tastes is influenced by dating irrespective of their ability to actually taste or smell a difference.

Environmental cues such as plate size and the presence of others influence the amount of food consumed.¹¹⁴

3.4 KEY WASTE BEHAVIORS

While it is not possible to definitively identify the major behavioral causes for food waste based on the literature, several behaviors stand out as leading to significant amounts of household food waste.¹¹⁵

They are:

- Buying too much food based on stock levels and likely use rates
- Buying ingredients for special recipes that are partially used
- Buying more fresh products, especially fruit and vegetables
- Improper storage and lack of storage and preservation knowledge and skills
- Preparing and serving too much food
- Not eating food while it is still fresh
- Not eating older stock and leftovers first
- Dissatisfaction with freshness or taste

Time availability seems to be a major indirect factor in food waste. However, it is less certain how time availability affects different behaviors. The principle behavior-influencing factors include: convenience of the behavior (or time it takes to execute the behavior); waste aversion (or dislike of wasting food); cost; gratification; knowledge and skills needed to execute the behavior; health benefits of the behavior; and whether the behavior is habit (that is, done fairly automatically and without much thought). How much to buy of a given item is often an automatic decision regulated by an anchor based on past usage (how much do I use routinely), intended future usage (how much do I think I can use), and average inventory.

¹¹² Morgan, Emily, "Fruit and Vegetable Consumption and Waste in Australia." (2009).

<http://www.vichealth.vic.gov.au/~media/ResourceCentre/PublicationsandResources/healthyeating/FruitVegConsumptionWaste.ashx>.

¹¹³ Wansink, Brian, and Alan O. Wright, "Best if Used By?" How Freshness Dating Influences Food Acceptance." *Journal of Food Science* 71, no. 4 pp. S354-S357 (May, 2006)

<http://doi.wiley.com/10.1111/j.1750-3841.2006.00011.x>.

¹¹⁴ Wansink, Brian, "Environmental Factors that Increase the Food Intake and Consumption Volume of Unknowing Consumers." *Annual review of nutrition* 24, no. 217 (January) pp. 455-79 (2004).

<http://www.ncbi.nlm.nih.gov/pubmed/15189128>.

¹¹⁵ Cox, Jayne, and Phil Downing, "Food Behaviour Consumer Research: Quantitative Phase." (WRAP Report, 2007).

Glanz, Robert, "Causes of Food Waste Generation in Households – An Empirical Analysis." *Applied Sciences* (2008).

4.0 OPPORTUNITIES ASSESSMENT

The Community Food Waste Prevention Pilot aims to reduce the environmental impacts associated with wasteful consumption behaviors. The primary behavioral goals for consumers are to waste less food at home and to switch to a less resource-intensive diet. These goals encompass numerous behaviors.

The purpose of the assessment in this section is to identify three to five key behaviors with the potential to significantly reduce the impacts of food waste that would be targeted in the Pilot.

The assessment was conducted in two steps. In the first step, potential behaviors were ranked based on the literature. In the second, the West Coast Climate and Materials Management Forum (the Forum) reviewed and commented on the assessment.

4.1 POTENTIAL BEHAVIORS

A significant number of possible behaviors that would result in reducing household food waste have been identified through a review of the sustainable consumption and consumer behavior literature. Additional behaviors were identified through discussion with the Forum and in an interview with a zero waste household (that is, a household consciously practicing zero waste behaviors). The combined list of behaviors is presented in Table 3.

Following the guidelines for selecting behaviors described in the community-based social marketing literature, each behavior is 'weighted' along three dimensions¹¹⁶:

- Impact of Behavior: Assessment of the behavior's potential to significantly reduce the impact of wasting food based primarily on Section 2 findings.
- Penetration Potential: Assessment of the prevalence of the behavior (or the incidence of the counter behavior) based on findings in both Sections 2 and 3.
- Probability of Changing Behavior: Assessment of the benefits and barriers to change for the consumer drawing on the findings in Section 3.

The weightings of high, medium, and low represent a qualitative synthesis of the literature findings and observational data provided by the Forum during the behavior selection process (review of the draft report and a facilitated meeting to select the three to five behaviors).

Note that the target behaviors listed in the table are behavioral change goals and not the messaging that will be crafted during the design phase of the Pilot. The behavior "Store fruits and vegetables for maximum freshness", for example, may be messaged as "Keep it fresh and eat at its best."¹¹⁷

Figure 10 provides additional information with regard to the comparative ease of changing high impact behaviors. In the figure, related behaviors are grouped in columns. The lead behavior (the behavior with the greatest potential impact) in a given column is then mapped to associated benefits and barriers denoted by circles on the axes at the bottom of the figure. For example, the behavior

¹¹⁶ See McKenzie-Mohr, 2011.

¹¹⁷ "Love Food Hate Waste." (WRAP, 2007).
<http://www.lovefoodhatewaste.com>

Table 3: Assessment of Potential Behaviors to Reduce Food Waste and Its Impacts

Category of Behavior By Phase	Possible Behavior	Food Types Most Impacted	Impact of Behavior	Penetration Potential	Probability of Changing Behavior	Benefits and Barriers Influencing Probability Weightings
Pre-Shop Planning	Plan Meals	All, perishables	Medium	High	Low	Time and preparation skills barriers
	Make shopping list based on stores	All	High	Low	High	Cost and time benefit; anchor barrier
	Make shopping list with quantities based on stores and projected needs	All	High	High	Medium	Cost and time benefit; anchor barrier; time barrier
	Use technology to plan purchases	All	Medium	High	Medium	Possible cost barrier; technology barrier
Avoiding Over-Purchasing	Show discipline in store	All	Medium	Medium	Medium	Anchor and impulse barriers
	Buy specific-use products as close to date as possible	All, long shelf life items	High	Medium	Medium	Habit barrier
	Buy less at a time (smaller lot/bunch/package sizes)	All	High	High	Medium	Cost and time barriers; cost benefit; potential quality benefit; product availability barrier
	Buy loose produce instead of pre-packaged in certain amounts	Fruit, Vegetables	Medium	Low	High	Cost benefit
	Buy bulk foods to buy more exact quantity of food	Grains, Sweeteners	Low	Medium	High	Cost benefit
	Use technology to check home stock while shopping	All	Medium	Medium	Medium	Time benefit
	Don't shop hungry	All	Medium	Medium	Medium	Time barrier
Location of Shopping	Internet Shopping	All	Medium	High	Low	Convenience barrier
	More frequent shopping trips to closer locations	All, perishables	High	Medium	Medium	Quality benefit; potential health benefit
	Shop for produce last at grocery store	Fruit, Vegetables	Low	Medium	High	Cost benefit

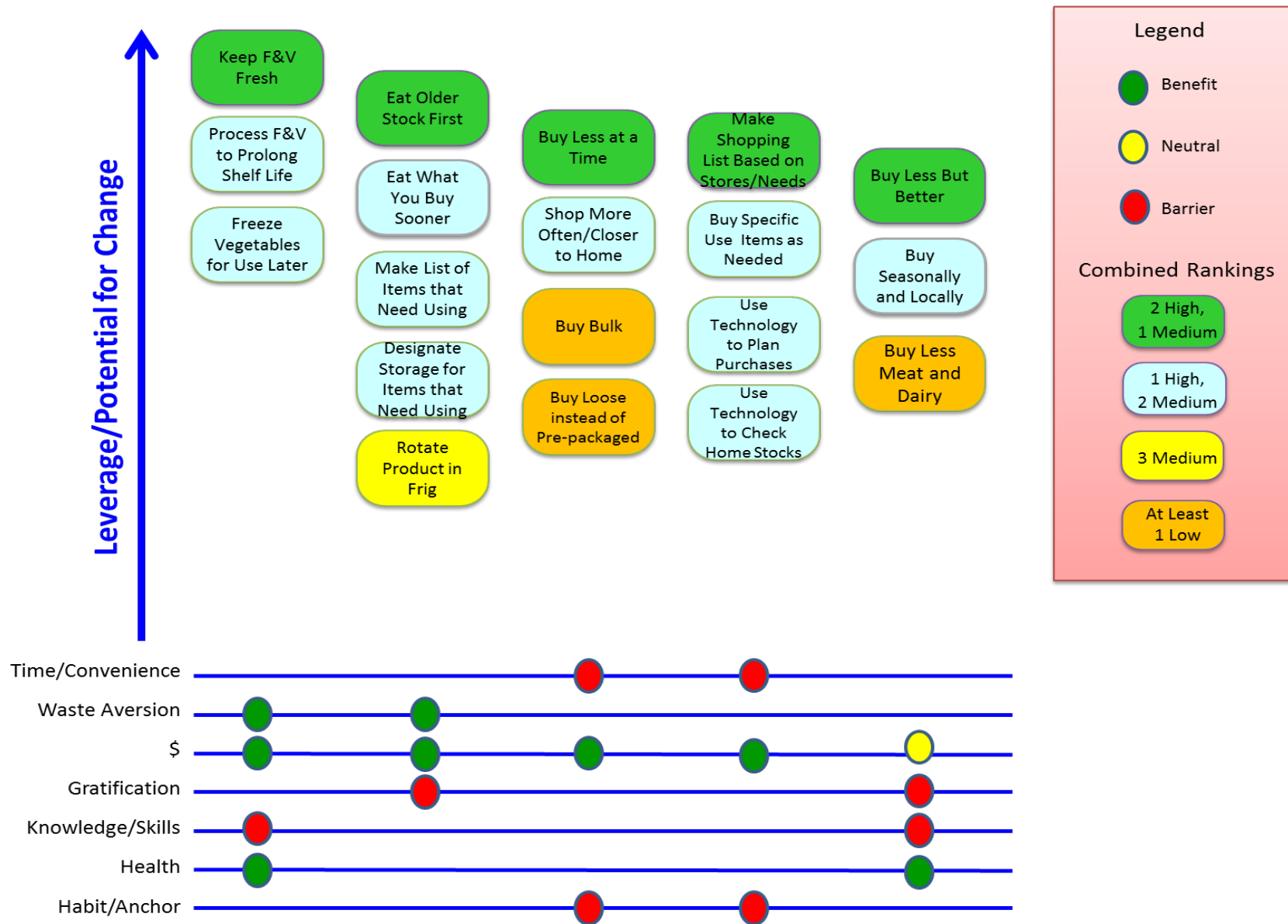
Table 3 (Continued): Assessment of Potential Behaviors to Reduce Food Waste and Its Impacts

Category of Behavior By Phase	Possible Behavior	Food Types Most Impacted	Impact of Behavior	Penetration Potential	Probability of Changing Behavior	Benefits and Barriers Influencing Weightings
Purchase Different Products	Buy seasonally and locally	Fruit, Vegetables	High	Medium	Medium	Cost benefit; information barrier
	Buy less but better	Meat, Dairy	High	High	Medium	Cost and information barriers; gratification barrier; health benefit; potential cost benefit
	Buy less meat and dairy	Meat, Cheese	High	Medium	Low	Cost and health benefits; knowledge and gratification barriers
	Buy familiar and easy-to-use substitute products for items not frequently used (e.g. corn meal for polenta, sandwich bread for hot dog buns)	All, Perishables	Medium	High	Medium	Knowledge barrier; Potential cost benefit
	Adapt to variability of supply and quality	Fruit, Vegetables	Low	Medium	High	Taste, quality and cost benefits
Storage	Rotate products from back to front of shelf	All	Medium	Medium	Medium	Time barrier
	Make list of items that need to be used up	All	Medium	High	Medium	Habit benefit; convenience and gratification barriers
	Designate storage space for items that need to be used up	All	Medium	High	Medium	Habit barrier
	Store fruits and vegetables for maximum freshness	Fruit, Vegetables	High	Medium	High	Cost, time and waste aversion benefits; knowledge barrier
	Store meat and dairy for maximum freshness	Meat, Dairy	High	Low	High	Cost and time benefits; knowledge barrier
	Process fruits and vegetables to prolong shelf life (e.g. canning)	Fruit, Vegetables	High	Medium	Medium	Cost benefit; initial cost barrier; time and knowledge barrier
	Freeze fruits and vegetables with limited shelf life for use later	Fruit, Vegetables	Medium	High	Medium	Knowledge barrier; cost and waste aversion benefits

Table 3 (Continued): Assessment of Potential Behaviors to Reduce Food Waste and Its Impacts

Category of Behavior By Phase	Possible Behavior	Food Types Most Impacted	Impact of Behavior	Penetration Potential	Probability of Changing Behavior	Benefits and Barriers Influencing Weightings
Preparation	Make extra, then freeze individual portions	All	High	Medium	Medium	Convenience and knowledge barriers; cost benefit
	Cook for more people	All	Medium	Medium	Low	Time and convenience barriers; possible social benefit
	Make best use of leftovers	All	Medium	High	Medium	Time, knowledge and convenience barriers
	Use technology to find uses for leftover items and dated items	All	High	Medium	Medium	Gratification barrier; technology barrier
	Use oven less often	Meat	Medium	Medium	Medium	Time benefit
	Proper portioning	All, Grains	High	Medium	Medium	Cost and time benefit; knowledge barrier
Eating	Serve sensible portions	All	High	Medium	Medium	Cost and health benefits; gratification barrier
	Ignore expiration dates	All	Medium	Medium	Medium	Health barrier
	Eat what you buy sooner	All	High	Medium	Medium	Gratification barrier
	Eat older stock and leftovers first	All	High	High	Medium	Gratification barrier; cost and waste aversion benefits
	Use smaller plates, bowls, utensils	All	Medium	Medium	Medium	Habit barrier
	Share meals	All	Medium	Medium	High	Social benefit
	Experiment with taste	All	Low	Medium	Medium	Gratification and knowledge barriers; habit barrier
Other	Grow food	Fruits, Vegetables	Medium	Medium	Medium	Gratification and health benefits
	Donate non-expired products to food kitchen	Canned Goods	Low	Medium	High	Gratification benefit
	Share extra items that will not be used in time	All	Medium	High	Medium	Social benefit

Figure 10: Assessment of High Impact Behaviors' Potential for Change



“Buy Less at a Time” is linked to a cost benefit and to both time/convenience and habit/anchor barriers. The further the column is to the left in the graph, the greater the balance of benefits and barriers – hence, the greater the potential to change the lead behavior. Note that only the lead behaviors’ potentials for change are reflected in the figure.

It is also useful to keep in mind that the assessment does not account for possible interactions between behaviors or for indirect, primarily social, benefits or barriers, such as supporting the local food economy.

4.2 SELECTED BEHAVIORS AND NEXT STEPS

Five behaviors have been identified through the assessment process as having two or more high ratings and no low ratings, that is, these five have the highest combined weightings of the identified behaviors.

1. **Store fruits and vegetables for maximum freshness:** This behavior involves relatively simple changes in how fruits and vegetables are stored using standard kitchen appliances and storage units (e.g. refrigerators, dark cupboards). It has high adoption potential as storage behaviors are not as complex and emotionally charged as purchasing and eating behaviors. The behavior also has a high impact weighting since fruits and vegetables comprise the bulk of the household food waste stream. Associated benefits of keeping fruit and vegetables fresh longer include waste aversion, health and cost savings. New storage behaviors may require additional knowledge but proper storage techniques are relatively easy and simple to learn.
2. **Eat older stock and leftovers first:** The impact of adopting this behavior is significant since the behavior leads to reductions in both volume wastes (fruits, vegetables) and resource-intensive wastes (meat, dairy). In addition, there is the potential to save money by not letting older items go to waste. However, eating fresher products is often preferred to eating older stock and leftovers. The WRAP campaign in the U.K. addressed this barrier by offering tasty recipes for using older stock and leftovers.¹¹⁸
3. **Buy less at a time (smaller lot/bunch/package sizes):** Over-purchasing relative to household needs is a leading cause of food waste, while buying less at a time is associated with wasting less. A probable barrier to purchasing smaller amounts of food at a time is the need to shop more frequently. This can be a particular challenge for families with small children. It is also a challenge to reset internal anchors regarding how much to buy. Product availability in smaller lot/bunch/package sizes may also be an issue.
4. **Make shopping list with quantities based on stores and projected needs:** A related behavior to buying less at a time is resetting internal anchors on how much to buy through using a shopping list that quantifies amounts to buy based on actual stores and projected needs, particularly near-term needs. With practice, using a shopping list could remove the need for additional shopping associated with buying less at a time.
5. **Buy less but better:** This behavior targets choosing environmentally-friendly and health-conscious alternatives to food items with high environmental impacts. It is suggested that the additional cost of purchasing and eating greener (i.e., less resource-intensive) substitutes will be off-set by purchasing less. The health benefits of eating less might also be used to promote this behavior. (Note that the planning team later replaced this target behavior with “prep perishables sooner than later” in the actual pilot design to align with an overall focus on preventing produce waste.)

¹¹⁸ “Love Food Hate Waste.” (WRAP, 2007). <http://www.lovefoodhatewaste.com>

The Forum also considered which of the five behaviors were most likely to be adopted by the two target demographics of families with small children and full-time workers under 35. These two demographics were identified in the research as those with the highest amounts of waste per household. Keeping fruits and vegetables fresh is likely to interest both demographics. Families with young children might also be amenable to adopting the eating older stock and leftovers, particularly as cost savings are often important to this demographic. Younger full-time workers might be a good target for messaging around buy less but better.

It is likely that no one behavior will dramatically reduce food waste by itself, rather the behaviors are probably complementary to each other with respect to the food waste reduction goal. In this regard, the five selected behaviors cover the pre-shop-planning, shopping, storage, and eating phases in the consumption process.

4.3 NEXT STEPS – SUPPLEMENTAL INFORMATION ON KEY BARRIERS AND BENEFITS

The analysis provided above is intended to inform Step 2 of the project. In Step 2, feedback sessions were held for the purpose of identifying messaging and strategies aimed at changing wasteful consumption patterns. Findings from these meetings were reported to EPA and the Food Pilot Planning team of Forum members and analyzed with contractor support from EcoPraxis and Tetra Tech EMI. The summary of findings related to key barriers and benefits for each behavior is included below. Based on findings from feedback sessions and reviewing a summary of the interviews conducted with other food waste prevention pilot programs in the UK, Minnesota, Portland and San Francisco, the Pilot Planning team with contract support from EcoPraxis and Colehour+Cohen designed pilot strategies and messages for what is now known as the Food: Too Good to Waste Pilot Program. Additional background documents are available upon request by contacting the West Coast Forum co-leads at westcoastforum@epa.gov

Key Barrier and Benefits to Household Food Waste Prevention

These findings are based on research conducted in collaboration with the Food Pilot Planning team of state and local partners and subcontractor, Dr. Viki Sonntag of Ecopraxis. Note that primary barriers and benefits are identified in bold in the chart below.

Preliminary research results indicate that the major barriers to prevent the adoption of target behaviors include automatic behavior, time/convenience, and a “dynamic lifestyle.” Additionally, the benefits that are most likely to encourage change include health, waste aversion, and access to knowledge and skills.

Waste or loss aversion is one of the key benefits of food waste prevention behaviors. Research has shown that people dislike losing the value of resources they already own or have purchased even more than they enjoy a savings of equivalent value from new purchases.¹¹⁹

¹¹⁹ Thaler, R H, and C R Sunstein. 2008. *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Yale University Press.

Behavior	Benefit	Barrier
1. Make a shopping list with meals in mind	Waste aversion Saving money	Dynamic lifestyle Time Automatic behavior
2. Eat older stuff first	Waste aversion	Gratification Convenience
2b. Prepare items sooner	Convenience Saving money Health	Skills Knowledge
3. Buy less at a time	Waste aversion Saving money	Automatic behavior Dynamic lifestyle Packaging Time (if increased need to shop more often)
4. Keep Fruits and Vegetables Fresh	Waste aversion Health Saving money	Knowledge Time Not enough room in fridge

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