Characterization and Management of

Food Loss and Waste

in North America

Foundational Report

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List of Abbreviations, Acronyms, and Symbols

ARS	Agricultural Research Service (United States)
Aserca	*Agencia de Servicios a la Comercialización y Desarrollo de Mercados Agropecuarios* (Agency for Services to the Marketing and Development of Agricultural Markets) (Mexico)
BCCDC	British Columbia Centre for Disease Control
BOGOFL	Buy one, get one free later
Canirac	*Cámara Nacional de la Industria de Restaurantes y Alimentos Condimentados* (National Chamber of Restaurant and Spicy Food Industry) (Mexico)
CDC	Centers for Disease Control (United States)
CEC	Commission for Environmental Cooperation
Ceda	*Central de Abasto de la Ciudad de Mexico* (Central Supply Market of Mexico City)
Celac	*Comunidad de Estados Latinoamericanos y Caribeños* (Community of Latin American and Caribbean States)
Cenadi	*Centro Nacional de Acopio y Distribución* (National Center for Collection and Distribution) (Mexico)
CFIA	Canadian Food Inspection Agency
CIAD	*Centro de Investigación en Alimentación y Desarrollo* (Centre for Research in Food and Development) (Mexico)
CO_2e	carbon dioxide equivalents
Conafab	*Consejo Nacional de Fabricantes de Alimentos Balanceados y de la Nutrición Animal* (National Council of Producers of Balanced Food and Animal Nutrition) (Mexico)
Conacyt	*Consejo Nacional de Ciencia y Tecnología* (National Council for Science and Technology) (Mexico)
Conasupo	*Compañía Nacional de Subsistencias Populares* (National Company of Popular Substances) (Mexico)
Coneval	*Consejo Nacional de Evaluación de la Política Social* (National Council of Social Policy Evaluation) (Mexico)
FAO	Food and Agriculture Organization
FCPC	Food and Consumer Products of Canada
FDA	Food and Drug Administration (United States)
FLW	food loss and waste
FLWRS	Food Loss and Waste Accounting and Reporting Standard
FMI	Food Marketing Institution (United States)
FUSIONS	Food Use for Social Innovation by Optimizing Waste Prevention (Europe)
FWRA	Food Waste Reduction Alliance (United States)

GDP	gross domestic product
GHG	greenhouse gas
GMA	Grocery Manufacturers Association (United States)
GMI	Global Methane Initiative
HaFSA	Hospitality and Foodservice Agreement (United Kingdom)
ICI	industrial, commercial and institutional
IFPRI	International Food Policy Research Institute
ILO	international labor organization
IMT	*Instituto Mexicano del Transporte* (Mexican Transport Institute)
INECC	*Instituto Nacional de Ecología y Cambio Climático* (National Institute for Ecology and Climate Change) (Mexico)
INEGI	*Instituto Nacional de Estadística y Geografía* (National Institute for Statistics and Geography) (Mexico)
IPCC	Intergovernmental Panel on Climate Change
IPD	*Instituto para la Planeación del Desarrollo AC* (Institute for Planning Development) (Mexico)
kg	kilogram
LAFA	loss-adjusted food availability
LandGEM	Landfill Gas Emissions Model
LFHW	Love Food Hate Waste
MassDEP	Massachusetts Department of Environmental Protection
MLED	Mexico Low Emissions Development
MSW	municipal solid waste
NAAEC	North American Agreement on Environmental Cooperation
NAFTA	North American Free Trade Agreement
NAPECA	North American Partnership for Environmental Community Action
NGO	nongovernmental organization
NRA	National Restaurant Association (United States)
NRDC	Natural Resources Defense Council (United States)
NZWC	National Zero Waste Council (Canada)
OECD	Organization for Economic Cooperation and Development
OWMA	Ontario Waste Management Association
PAC	Packaging Association of Canada
PIM	policies, institutions and markets
Profepa	*Procuraduría Federal de Protección al Ambiente* (Federal Attorney Office for Environmental Protection)

ReFED	Rethink Food Waste through Economics and Data (United States)
Refresh	Resource Efficient Food and Drink for the Entire Supply Chain (Europe)
Sagarpa	*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación* (Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food) (Mexico)
SCT	*Secretaría de Comunicaciones y Transportes* (Ministry of Communications and Transport) (Mexico)
Sedesol	*Secretaría de Desarrollo Social* (Ministry of Social Development) (Mexico)
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Ministry of the Environment and Natural Resources) (Mexico)
Senasica	*Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria* (National Service for Food Health, Safety and Quality) (Mexico)
SDG	sustainable development goals
SIAP	*Servicio de Información Agroalimentaria y Pesquera* (Agri-Food and Fisheries Information Service)
Simapro	*Sistema Integral de Medición y Avance de la Productividad* (Integral System of Measurement and Productivity Improvement) (Mexico)
SME	small and medium-size enterprises
UBC	University of British Columbia
UFS	Unilever Food Solutions
UK	United Kingdom
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States of America
USDA	United States Department of Agriculture
USDA ERS	United States Department of Agriculture Economic Research Service
US EPA	United States Environmental Protection Agency
VCMI	Value Chain Management International
WaRM	Waste Reduction Model (US EPA)
WBCSD	World Business Council for Sustainable Development
WRAP	Waste and Resources Action Programme
WRI	World Resources Institute

Abstract

Food loss and waste (FLW) is an increasingly important issue in Canada, Mexico and the United States, where close to 170 million tonnes of food produced for human consumption are lost and wasted—across the food supply chain, including in pre-harvest and consumer sectors—each year. Food waste in landfills is a significant source of methane gas—a greenhouse gas (GHG) 25 times stronger than carbon dioxide. FLW also has environmental and socio-economic impacts, including: the inefficient use of natural resources; economic loss; biodiversity loss; and public health issues.

The Commission for Environmental Cooperation (CEC) established the North American Initiative on Food Waste Reduction and Recovery as part of its Green Economy and Climate Change portfolios. This report seeks to enhance the North American capacity to reduce disposal of food waste in the industrial, commercial and institutional (ICI) sector. It proposes comprehensive strategies to address source reduction of FLW, and for food rescue and recovery, at all stages of the food supply chain—from post-harvest food production, processing and distribution, to consumer-facing foodservice and retail sectors. Following an analysis of the current state, causes and impacts of FLW in North America, this report identifies opportunities to reduce FLW through source reduction, and food rescue or recovery of surplus food. Estimates of FLW quantities, along with associated environmental and socio-economic impacts, are also provided. The analysis, opportunities and suggestions presented in this report are a useful reference for the ICI sector, governments, and nongovernmental organizations (NGOs) as they develop policies, strategies and initiatives to address FLW in North America.

Executive Summary

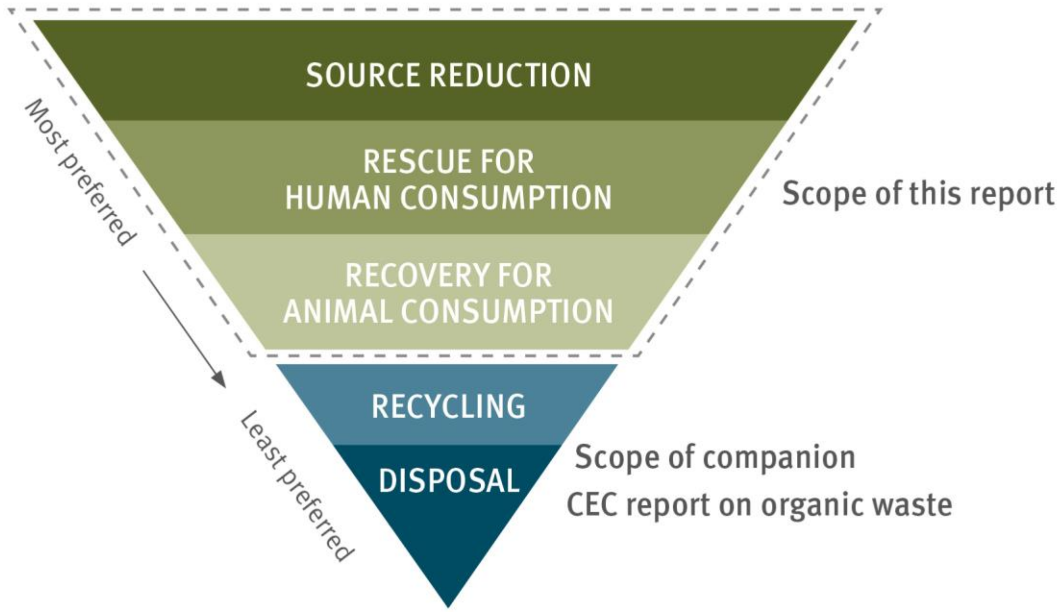
Policies and programs on food loss and waste (FLW) are gaining momentum across North America as awareness of the issue continues to grow. The Commission for Environmental Cooperation (CEC) established the North American Initiative on Food Waste Reduction and Recovery as part of its Green Economy and Climate Change project areas.

This report characterizes FLW in Canada, Mexico and the United States and identifies opportunities for the industrial, commercial and institutional (ICI) sector, governments, and nongovernmental organizations (NGOs) to take action across the three countries.

By highlighting success stories as well as examining challenges and opportunities to implementing change, the report provides foundational information to help inform country-level strategies and support international and domestic commitments. This report also highlights regional cooperation opportunities to minimize FLW generation and redistribute surplus food in adherence with the food recovery hierarchy adapted from multiple sources (see below), with a focus on source reduction, rescue for human consumption and recovery for animal consumption.

This project complements the CEC's North American Initiative on Organic Waste Diversion and Processing, which examines composting, anaerobic digestion, and other industrial processes (e.g., rendering, biofuel) for FLW and other organic waste. As shown in Figure ES1, Food Recovery Hierarchy, below, together these two projects provide an overview of FLW source reduction, food recovery and recycling in North America.

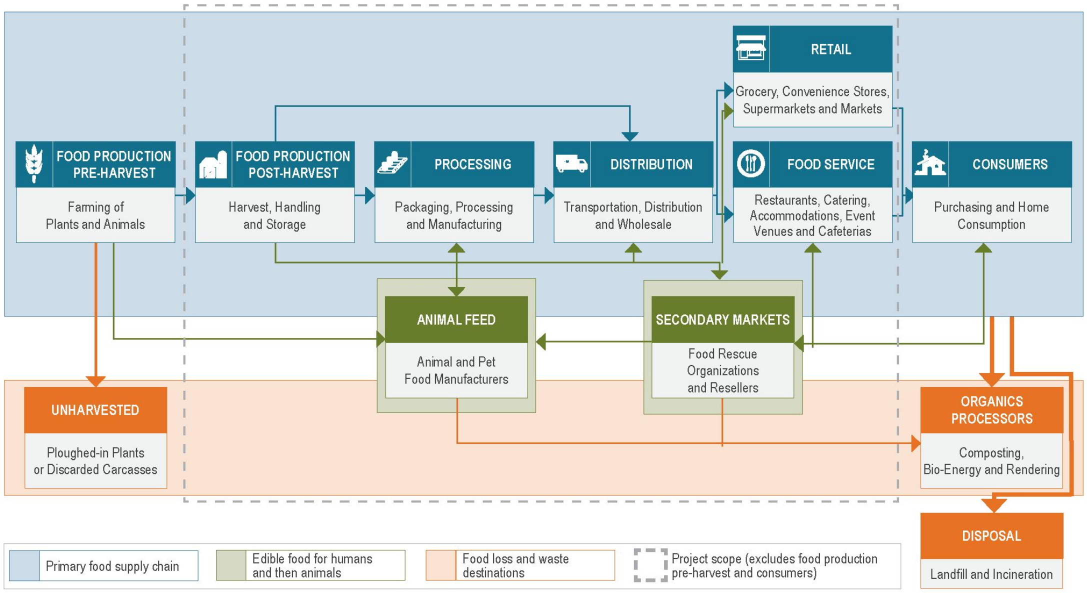
FIGURE ES1. Food Recovery Hierarchy



Source: Adapted from EPA 2016a; MacRae et al. 2016; Papargyropoulou et al. 2014; Kelly 2014; WRAP 2013.

In general, the scope of this project work has been limited to the post-harvest to pre-consumer stages of the food supply chain (i.e., post-harvest food production, processing, distribution, retail and food service). Pre-harvest food production and consumer stages of the food supply chain were included for the purpose of quantifying FLW in each of the three North American countries, and estimating some environmental and socio-economic impacts.

FIGURE ES2. Overview of the Food Supply Chain



Note: Pre-harvest food production and consumer stages of the food supply chain were included for the purpose of quantifying FLW in each of the three North American countries, and estimating some environmental and socio-economic impacts.

The content of this report was compiled from primary and secondary sources of information in Canada, Mexico, the United States and countries outside of North America. Primary sources included interviews and email exchanges with stakeholders representing various locations, organization types and sizes, and stages of the food supply chain. A total of 167 interviews were conducted for this project. The interviewees' countries of origin were as follows: 46 from Canada, 78 from Mexico, 41 from the United States, and two from countries outside of North America. Secondary sources included reports, white papers, academic papers, news articles, media recordings and government databases as well as a review of on-the-ground programs and projects implemented by the ICI sector, governments and NGOs. North American and international experts on the subject matter also vetted key findings during a three-day stakeholder session held in Canada, in February 2017.

Key Findings

Key findings related to FLW quantification, causes, environmental and socio-economic impacts, stakeholder benefits, approaches to mitigate FLW, and opportunities for action are summarized below.

Quantification

To derive the North America–wide FLW data in this report, the research team used a global FLW quantification methodology based on the United Nations Food and Agricultural Organization (FAO) estimates for food produced, by product group. Applying the FAO methodology, the estimates are as follows:

- Approximately 168 million tonnes of FLW are generated in North America each year. This estimate encompasses all stages of the food supply chain, including the pre-harvest and consumer stages. Per country, this equates to 13 million tonnes in Canada, 28 million tonnes in Mexico and 126 million tonnes in the United States.[1] When excluding the pre-harvest and consumer stages, approximately 52 million tonnes of FLW are generated in North America each year. Per country, this equates to about 4 million tonnes in Canada, 15 million tonnes in Mexico and 33 million tonnes in the United States.

- When including all stages of the food supply chain, per-capita FLW in Canada is comparable to that in the United States (396 kilograms/person/year and 415 kilograms/person/year, respectively). The per-capita FLW generation in Mexico is much lower—249 kilograms/person/year. Nevertheless, when excluding pre-harvest and consumer stages, rates across all three countries are comparable: 110 kilograms/person/year in Canada and the United States each, and 129 kilograms/person/year in Mexico.

Primary Causes

Causes of FLW across the food supply chain include:

- overproduction by processors, wholesalers and retailers;
- product damage;
- lack of cold-chain infrastructure (refrigeration during transportation and storage);
- rigid food-grading specifications;
- varying customer demand; and
- market fluctuations.

Key players such as farmers, processors, distributors, retailers, food-rescue organizations and other service providers can influence how products are moved along the food supply chain.

Environmental and Socio-Economic Impacts

The environmental and socio-economic impacts of FLW across the food supply chain are significant. Using multiple recent studies, including the FAO's *Food Wastage Footprint* (FAO 2013), the research team derived estimates of the environmental and socio-economic impacts of FLW for North America per year[2]:

- 193 million tonnes of greenhouse gas (GHG) emissions of carbon dioxide equivalent (CO_2e) for life-cycle of landfilled FLW;
- 17.6 billion cubic meters (m^3) of water used;

[1] By comparison, other estimates of FLW per year range from six to 13 million tonnes in Canada, 12 to 21 million tonnes in Mexico and 35 to 60 million tonnes in the United States. These estimates of FLW quantities were derived from varying stages of the food supply chain, food types, methodologies, and definitions of FLW.

[2] Country-specific estimates for each environmental and socio-economic impact category are set out in Tables 42 and 43. The FAO categorizes the United States, Canada, Australia and New Zealand as North America and Oceania region (Gustavsson et al. 2011). Mexico is grouped with Latin America, which combines the Caribbean region, Central America and South America. When country-specific information was not available, regional or global data were extrapolated to provide a basic description of the environmental and socio-economic impact of FLW in each of the North American countries.

- 22.1 million hectares (ha) of cropland used;
- 3.94 million tonnes of fertilizer used;
- 13.3×10^{18} Joules of energy used;
- 38.6 million m^3 of space used in landfill;
- US$1,867 million spent in tipping fees;
- US$278 billion in market value of FLW lost;
- US$319 million–equivalent in loss of biodiversity; and
- 217 trillion kilocalories (kcal—1,000 calories) in potential energy lost.

Stakeholder Benefits from Reducing Food Loss and Waste

Stakeholder benefits from investing in and implementing approaches for source reduction of FLW, food rescue and recovery, and measuring, tracking and reporting are manifold. These benefits are categorized and displayed in Table ES1.

TABLE ES1. Potential Benefits from Addressing Food Loss and Waste

	Type of Approach		
Stakeholder	Reduction	Rescue and Recovery	Measuring, Tracking and Reporting
ICI	▪ Increase sales and revenue from untapped markets ▪ Operational efficiencies and savings ▪ Positive brand recognition ▪ Corporate social responsibility ▪ Potential job creation ▪ Reduce pollution and greenhouse gas emissions	▪ Mitigate costs of disposal ▪ Positive brand recognition ▪ Increase employee morale ▪ Corporate social responsibility ▪ Reduce pollution and greenhouse gas emissions	▪ Identify root causes of FLW ▪ Use data to drive change and develop FLW solutions ▪ Track employee and operational performance ▪ Employee engagement
Government	▪ Conserve natural resources ▪ Mitigate habitat loss ▪ Reduce pollution and greenhouse gas emissions ▪ Mitigate disposal costs ▪ Optimize infrastructure/utilities to support food production, processing and distribution	▪ Conserve natural resources ▪ Mitigate habitat loss ▪ Reduce pollution and greenhouse gas emissions ▪ Lower costs for waste management ▪ Augment social programs for food assistance and ensure food security	▪ Measure, track and evaluate progress on FLW targets or goals ▪ Use data to develop FLW policies ▪ Increase accountability on meeting FLW commitments
NGO	▪ Achieve organizational mandates for environmental and/or social impacts	▪ Achieve organizational mandates for environmental and/or social impacts ▪ Reduce food procurement costs (for food rescue only) ▪ Increase quality of food ▪ Improve supply management	▪ Provide evidence base for advocacy efforts on FLW ▪ Evaluate effectiveness of solutions

Approaches

The research team used reports, interviews and conference proceedings to identify a number of approaches to source reduction of FLW; food rescue and recovery; and measuring, tracking and reporting. These approaches can address causes of FLW along specific areas of the food supply chain, inform policy and education programs, and contribute to fulfilling federal government commitments. The approaches are as follows:

Source Reduction

- **Reducing Portion Sizes**, to reduce plate waste and address over-serving, plate composition and tray use.
- **Increasing Marketability of Produce**, to increase use of second-grade produce, adjust government and/or grading requirements, increase merchandising standards and reduce shipments rejected.
- **Standardizing Date Labels**, to reduce wasted food caused by confusion related to date labels, through standardization and education of key players across the food supply chain.
- **Packaging Adjustments**, to manage portion size, reduce damage during transport and increase shelf life.
- **Improving Cold-Chain Management**, to avoid rejection of shipments due to spoilage caused by cold-chain (refrigeration) deficiencies related to infrastructure and management.
- **Value-Added Processing,** to cultivate secondary markets for damaged or surplus food and byproducts.

Food Rescue and Recovery

- **Increasing Rescue of Healthy Food**, to capture second-grade and other surplus food.
- **Storage and Transportation Improvements**, to expand temperature-controlled distribution and cold infrastructure for donated food.
- **Financial Incentives for Food Donation**, to encourage food donation and increase capture of second-grade and surplus products.
- **Liability Protection for Food Donors**, to protect donors from liability for donated food and to educate potential donors about related regulations.
- **Online Food Rescue Platforms**, to match generators of surplus foods to buyers and charities.
- **Feeding Animals**, to increase capture of nutritious surplus food or byproducts.

Measuring, Tracking and Reporting

- **Waste Composition Analysis**, to physically sort FLW from other material in order to determine weight and composition.
- **Diaries**, to maintain a daily record or log of FLW and other information.
- **Surveys**, to gather data on FLW quantities and other relevant information from a large number of individuals or entities through a set of structured questions.
- **Models and Proxy Data Extrapolation**, to utilize data to infer quantities, by using a mathematical approach based on the interaction of multiple factors that influence the generation of FLW.

Opportunities

There are promising opportunities to develop policies, strategies and initiatives to address FLW in North America in collaboration with relevant stakeholder organizations. Some opportunities are cross-cutting, while others specifically address source reduction of food waste; food rescue and recovery; or measuring, tracking and reporting.

Cross-cutting

- **Develop FLW Policies**: establish and/or reinforce policies that address FLW, either as a stand-alone initiative or as a component of other policies (e.g., national food policy, hunger relief, calls-to-action) at the national, provincial/state and municipal levels of government.
- **Foster Multi-Stakeholder Collaboration**: develop and/or expand upon multi-stakeholder partnerships or agreements for collaboration toward FLW initiatives and research in each North American country, as well as among the countries.
- **Create Voluntary ICI FLW Initiative**: establish and/or reinforce a voluntary FLW reduction target or call-to-action to encourage ICI stakeholders to commit to taking action on FLW.
- **Strengthen Regional Collaboration**: form a North American advisory committee with a focus on FLW.

Source Reduction

- **Standardize Date Labels**: establish a guideline that standardizes date labels across the North American countries.
- **Update Food Grading**: change cosmetic requirements for food grading to categorize more food as acceptable for primary markets and harmonize grading guidelines across the North American countries.
- **Improve Cold-Chain Management**: optimize use of appropriate vehicles and storage facilities, to minimize FLW.
- **Expand Value-Added Processing and Packaging Innovation**: develop technologies to extend the freshness or shelf life of food through innovation in value-added processing and packaging.

Food Rescue and Recovery

- **Explore Food Rescue Incentives**: establish tax incentives for food donations (if not already existing) and expand funding/in-kind donations for improved infrastructure related to storage, transportation and donation tracking.

Measuring, Tracking and Reporting

- **Standardize Measuring, Tracking and Reporting**: use terms, definitions and reporting framework, in each country, that are consistent with the Food Loss And Waste Accounting and Reporting Standard (FLWRS).
- **Track and Report Performance**: establish benchmark (baseline) FLW for each country, optimize performance and inventory management for the ICI sector and track changes in FLW over time.

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1 Introduction

The Commission for Environmental Cooperation (CEC) is an intergovernmental organization comprising Canada, Mexico and the United States under the North American Agreement on Environmental Cooperation (NAAEC). The CEC was created to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote effective enforcement of environmental law. The CEC's Council[3] approved the North American Initiative on Food Waste Reduction and Recovery project as part of its 2015–2016 Operational Plan. The project's purpose is to enhance North America's capacity for reducing food loss and waste (FLW) by exploring ways to prevent and reduce FLW during processing, distribution, retail and foodservice sectors, and to redirect food from landfill disposal. Project outcomes include this foundational paper and its accompanying white paper, as described further below. This project was carried out simultaneously and in conjunction with a companion CEC project entitled North American Initiative on Organic Waste Diversion and Processing, which includes an examination of food waste recycling efforts and supports international commitments that are of interest to Canada, Mexico and the United States.

FLW has become an increasingly relevant issue in recent years. The United Nations Food and Agriculture Organization (FAO) estimates that, globally, one-third of the food produced for human consumption is wasted—approximately 1.3 billion tonnes per year (Gustavsson et al. 2011). Several global initiatives to tackle this issue are in progress. The United Nations Sustainable Development Goal 12.3 aims to halve per-capita global FLW at the retail and consumer level and reduce food losses along production and supply chains, including post-harvest losses, by 2030 (United Nations 2016). In 2011, the FAO and Messe Düsseldorf established Save Food, a worldwide initiative to fight food loss and waste (Save Food n.d.). Born out of the Save Food initiative is the Think.Eat.Save. campaign, a partnership among the United Nations Environment Programme (UNEP), FAO and Messe Düsseldorf, developed in support of the UN Secretary-General's Zero Hunger Challenge (UNEP 2013).

While there are many FLW policies and programs across North America, as reviewed in this report, FLW-related initiatives are still in preliminary stages. A comprehensive FLW strategy would help mitigate food insecurity, resource depletion (e.g., water and nutrients), and greenhouse gas (GHG) emissions while increasing business profitability and efficiency, by reducing unnecessary decomposition of organics during production and transportation and reducing disposal to landfill. This project takes the necessary first steps in characterizing FLW and identifying FLW reduction strategies in the industrial, commercial and institutional (ICI) sector, governments and nongovernmental organizations (NGO) across North America. By highlighting success stories as well as examining challenges to and opportunities for implementing change, this report provides foundational information to help inform country-level strategies for Canada, Mexico and the United States. The report also highlights regional cooperation opportunities to minimize FLW creation and redistribute excess food in adherence with the Food Recovery Hierarchy described in Section 2.1.2.

1.1 Approach and Outline

This report is based on information from primary and secondary sources in Canada, Mexico, the United States and selected countries outside North America.

[3] The CEC Council comprises the heads of Environment and Climate Change Canada, the United States Environmental Protection Agency, and Mexico's Ministry of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*—Semarnat).

Primary sources included interviews and emails with key stakeholders throughout the food supply chain (e.g., ICI, government, nongovernmental organizations) within each country. Interviewees were prioritized to ensure representation across parameters such as geography, size and stage of the food supply chain, and stakeholder type. A total of 167 interviews were conducted for this project. The interviewees' countries of origin were as follows: 46 from Canada, 78 from Mexico, 41 from the United States, and two from countries outside of North America. Stakeholder input was also compiled from the North American Workshop on Food Waste Reduction and Recovery, held in Canada in February 2017.

FLW-related policies and programs and the related quantification of FLW across the supply chain are in earlier stages of development in Mexico, as compared to Canada and the US, which posed a challenge to the study. Due to the limited amount of published information about FLW in Mexico, a greater number of interviews were needed there than in Canada or the United States, in order to collect unpublished primary data. Despite the high number of interview requests, limited responses were obtained from members of Mexico's processing sector, as they generally did not see FLW as a priority.

The research team conducted a literature review for all three countries, to gather additional information, including reports, white papers, academic papers, news articles, media recordings and government databases. The literature review also included a scan of on-the-ground programs and projects implemented by ICI, government and NGOs.

This report contains eight sections, outlined below, along with a summary of section-specific methodologies. As relevant, sections address specific issues, obstacles or opportunities in cross-border or regional cooperation.

Section 1 outlines the objective and scope of this foundational report, and gives an overview of the food supply chain. It defines the stages of the food supply chain relative to this report, along with the stakeholders that play a crucial role in the primary food supply chain. Section 1 also describes the approach taken, with a brief outline of each section of the report.

Section 2 defines several terms related to FLW, introduces the food recovery hierarchy and gives an overview of how each of the three countries quantifies FLW. This section provides an overview of the causes of FLW globally, in North America and by country. It uses existing reports and databases to estimate FLW quantities for Canada, Mexico and the United States. Where limited published information was available, the report utilizes extensive interview results and other published, indirect information sources to gain insights on FLW characterization.

Sections 3, 4 and 5 address source reduction of FLW; food rescue and recovery; and measuring, tracking and reporting; respectively. Each section defines the topic, discusses its significance and outlines its associated challenges. Specific approaches on each topic, based on research of existing initiatives, are presented, including description, relevant stakeholders, trends, challenges and special considerations for implementation. The selection of approaches for these three sections was based on a comparison of leading reports in North American countries, as well as on best practices and innovations from outside North America (for example, other Organization for Economic Cooperation and Development [OECD] countries) that are transferable to or adaptable for Canada, Mexico or the United States. Interviews were conducted to prioritize the approaches to be included in the report, as well as to gain additional insights on implementation realities.

Section 6 links wasted food to GHG emissions and describes the impact of wasted food on the environment and on socio-economic factors. It links FLW to greenhouse gases (GHGs) through estimations of the Intergovernmental Panel on Climate Change (IPCC) for methane gas generation and landfill gas capture, and shows the potential reduction of GHGs from wasting less food. Other environmental and socio-economic impacts of FLW are reviewed, with note of indicators for tracking, where available.

Section 7 outlines recommendations and strategies for each main area covered in the report: source reduction of FLW; food rescue and recovery; and measuring, tracking and reporting. Considerations related to incorporating recommendations are provided, by country, and opportunities for trilateral collaboration are indicated.

Section 8 provides limitations related to research and analysis conducted for the report, including information gaps and potential areas for improvement.

Section 9 describes case studies of actions by organizations, businesses, and governments across the three countries, that have been carried out in pursuit of reducing FLW. Each case study illustrates one of the approaches outlined in sections 3, 4 and 5.

1.2 Scope of Report

The report characterizes the causes of FLW generation, identifies initiatives aimed at reducing, rescuing, recovering and measuring wasted food, and identifies challenges to—and key opportunities for—successful implementation. FLW projects, programs and policies are being implemented across North America; this report provides a general analysis of the successes and challenges of different approaches, including the impacts of regulatory and non-regulatory tools. The report also includes recommendations for improving source reduction of FLW, rescue and recovery of food, and measurement efforts, along the food supply chain, and provides an analysis of environmental benefits resulting from avoidance of FLW.

This report focuses on key opportunities for FLW reduction, as well as rescue and recovery of wasted food (i.e., surplus food), in the following stages of the food supply chain: post-harvest food production; processing; distribution; retail; and foodservice. This report does not address FLW during pre-harvest food production (e.g., FLW resulting from weather, pests or lack of technology), or at the consumer level (e.g., food waste in homes). Pre-harvest food production is a critical part of the food supply chain, governed by a separate set of agricultural policies and programs, and is worthy of study under a separate scope. For consumer-facing retail and foodservice stages of the food supply chain, relevant education and awareness initiatives related to source reduction, rescue and recovery, and measurement are noted in Section 3.5, Policy and Education/Awareness Program Opportunities.

Food waste recycling, including composting and anaerobic digestion, is examined in the companion report by the CEC, entitled *Characterization and Management of Organic Waste in North America* (CEC 2017a). Together these two reports provide a comprehensive overview of FLW and organics management in North America.

This report quantifies and characterizes FLW and assesses approaches and initiatives for avoidance of FLW through reduction, rescue and recovery in the following stages of the food supply chain: post-harvest handling and storage, processing, distribution, retail and foodservice. The following section provides a visual description of the food supply chain, and definitions of food supply chain stages. Key stakeholders referred to frequently throughout the report are also defined.

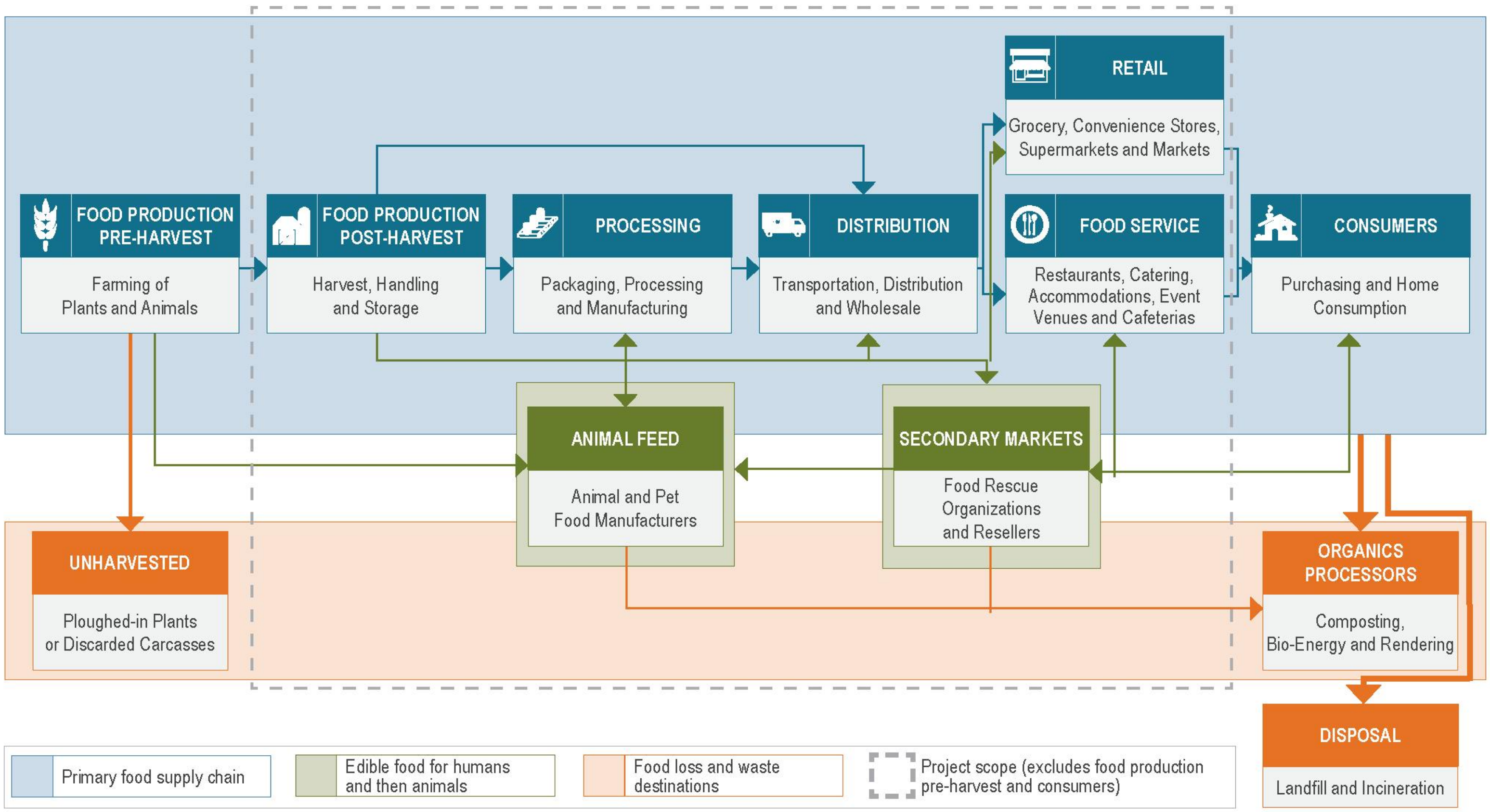
1.2.1 Overview of the Food Supply Chain

Figure 1 is a schematic showing a simplification of the food supply chain and the general flow of food between its various stages. The stages included in this study are found within the grey, dashed outline of the rectangle.

The primary food supply chain—depicted in the figure in shades of blue—is the typical path of food destined for human consumption. The secondary markets for food originally intended for human consumption are shown in green. One alternative destination for food that leaves the primary food supply chain is animal feed, which is also shown in green.

Figure 1 also depicts—in orange—the handling of food that is no longer destined for human consumption. This includes crop not harvested (or harvested and then abandoned), crop residuals, and food processed as waste (e.g., recycled, or disposed of). Food processed as waste is broken down into two categories: organics processing and disposal.

FIGURE 1. Overview of the Food Supply Chain



Note: Pre-harvest food production and consumer stages of the food supply chain were included for the purpose of quantifying FLW in each of the three North American countries, and estimating some environmental and socio-economic impacts.

1.2.2 Stages of the Food Supply Chain Examined

This report focuses on the following stages of the food supply chain, which are briefly described below. Note that pre-harvest food production and consumer stages of the food supply chain were included for the purpose of quantifying FLW in each of the three North American countries, and estimating some environmental and socio-economic impacts.

1.2.2.1 Post-Harvest Food Production

Post-harvest Food Production covers the post-harvest activities at the farm level and those occurring outside the agricultural sector— activities that involve harvesting, handling and storage of plants or their parts, or of animals (livestock, poultry, seafood) or their parts (adapted from FAO 2017). These activities are defined as follows (Grolleaud 2001):

Harvesting: The process of gathering crops, butchering livestock, or catching seafood, the timing of which is usually determined by the degree of maturity. For the purposes of this report, harvesting was included in order to recognize approaches for food rescue such as gleaning, and dealing with biases against cosmetic flaws.

Handling: Includes post-harvest drying, threshing, cleaning, and movement of product to storage or distribution.

Storage: Areas where products remain for a period of time before distribution. Factors that affect storage quality include the physical facility, hygiene and monitoring. Control of cleanliness, temperature and humidity can determine product quality.

The top (by weight) three types of food produced, by country, based on annual production in the referenced year, are shown in TABLE 1.

TABLE 1. Top Three Types of Food Produced, by Country

Country	Food Category	Annual Production (tonnes)	Reference Year
Canada (Statistics Canada 2017a)	Wheat and wheat products	31,728,600	2016
	Canola and mustard seed	18,657,500	2016
	Maize	13,193,100	2016
Mexico (FAO 2017)	Maize	23,273,000	2014
	Milk	11,129,000	2014
	Sorghum	8,394,057	2014
United States (FAO 2017)	Maize	354,000,000	2013
	Soybeans	91,400,000	2013
	Milk	91,300,000	2013

1.2.2.2 Food Processing

This stage includes both food processing/manufacturing and packaging. These activities are defined as follows:

Food Processing: The transformation of raw foods into products suitable for consuming, cooking or storage (European Food Information Council 2016). For the purposes of this project, the term "food processing" is interchangeable with "food manufacturing".

Packaging: The process of containing food for preservation, food safety (as a barrier against bacterial contamination, pests, physical damage), and ease of transport, storage and use (Food System Primer n.d.).

Food processing is one of the largest industries across North America, representing 15 to 23% of the general manufacturing industry (USDA ERS 2016a; Agriculture and Agri-Food Canada 2014a; ProMéxico 2015, 10–11). Processing facilities are generally concentrated in certain geographic regions in each of the countries. In Canada, 75% of all food production companies are located in three of the 10 provinces: Ontario, Quebec and British Columbia (Statistics Canada 2014). In Mexico, more than 50% of the food processing industry is concentrated in Ciudad de México and seven of the 31 states: Estado de México, Oaxaca, Veracruz, Puebla, Guanajuato, Jalisco and Michoacán (INEGI 2014b). In the United States, the leading food processing states are California, New York and Texas (USDA ERS 2016a).

The top three food processing sectors, by country, per year listed, based on economic value (normalized to 2016 US$), are shown in TABLE 2.

TABLE 2. Top Three Processing Sectors, by Country

Country	Food Category	Economic Value (normalized to 2016 US$)	Reference Year
Canada (Agriculture and Agri-Food Canada 2016a)	Meat	20.1 billion	2014
	Dairy	13.2 billion	2014
	Grain and oilseeds	8.09 billion	2014
Mexico (Ornelas 2015)	Bakery products and tortillas	36.8 billion	2013
	Meat and poultry processing	35.3 billion	2013
	Dairy processing	14.5 billion	2013
United States (USDA 2016c)	Meat	864 billion	2013
	Dairy	35.7 billion	2015
	Grains and oilseeds	31.5 billion	2016

1.2.2.3 Distribution

Distribution encompasses the transportation and distribution of food products before reception by the consumer, and includes wholesaling and brokering (adapted from Perner 2008). These activities are defined as follows:

Transportation: The movement of food between point of origin and point of use (Keener 2003).

Brokering: Food brokers facilitate the sales between retailers and manufacturers, but do not handle any food themselves. Large companies, such as grocery store chains, generally do not go through brokers and instead run their own distribution centers and are known as "self-distributing retailers" (Beaman and Johnson 2006, 1–2).

Wholesale: Where goods are assembled, stored and transported to retailers, foodservice operators, other wholesalers, government, and other types of ICI stakeholders (USDA ERS 2016b).

While information on the scale or economic value of the sub-sectors in distribution was not available for each country, the USDA reported that 3.2 cents for every American dollar spent on food in the United States go toward transportation (USDA ERS 2016c).

1.2.2.4 Retail

Retail is the sale of food in businesses that serve the consumer directly (e.g., in a store or market setting), to be used in households (not sales in restaurants or institutional settings) (adapted from Suttle n.d.).

Examples of retail include (adapted from Food Retail World 2015):

Convenience stores: Small, accessible stores offering a limited assortment of products, prominently snack foods.

Grocery stores: Stores up to 190 square meters (m^2) in size, offering perishable products such as meat or produce, as well as nonperishable items.

Supermarkets: Stores over 190 m^2 in size, offering a full line of groceries, meat and produce.

Markets: Gatherings of independent retailers, such as farmers, distributors, and independent food processors (including small *mercados*), in a designated area, on regularly scheduled days that may be seasonal.

The top three retailing sectors, by country, based on economic value for year listed, are shown in TABLE 3.

TABLE 3. Top Three Retailing Sectors, by Country

Country	Category	Economic Value (US$)	Reference Year
Canada (Statistics Canada 2017b)	Supermarkets	61.2 billion	2015
	Convenience Stores	6.9 billion	2015
	Specialized Stores	5.3 billion	2015
Mexico (Ornelas 2015)	Supermarkets	58.1 billion	2013
	Wholesalers/Distributors	45.9 billion	2013
	Other*	33.0 billion	2013
United States (USDA ERS 2016c)	Grocery Stores	519 billion	2011
	Convenience	31.4 billion	2011
	Specialized Stores	19.4 billion	2011

* Most (93%) of retail in Mexico takes place in smaller neighborhood stores such as fruit and vegetable stores (*recauderías*), meat stores (*carnicerías*), chicken stores (*pollerías*) and bread stores (*panaderías*) (INEGI 2014b). However, the prices of goods in these stores are generally lower.

1.2.2.5 Foodservice

Foodservice covers preparation and serving of meals, snacks and beverages for consumption outside of the home (or for take-out), in dining or fast-food establishments, and within commercial and institutional settings, as defined below (adapted from Fonterra Co-operative Group n.d.):

Commercial settings: Private businesses such as restaurants, event venues, accommodations, cafeterias and caterers.

Institutional settings: Cafeterias or foodservices in schools, hospitals, correctional facilities, nursing homes, childcare facilities and any other entity where food is served as part of a meal program.

Types of foodservice are defined as follows:

Restaurants: Full-service restaurants (such as Swiss Chalet or Cheesecake Factory), or quick-service restaurants (such as McDonald's or Burger King).

Event Venues: Food vendors included as part of sports arenas or performance theaters.

Catering: Businesses that provide foodservices for social events or meetings, typically at sites that do not have in-house foodservice.

Accommodations: Foodservice providers within settings with lodging, such as hotels.

Cafeterias: Foodservice facilities where customers serve themselves from counters offering a variety of prepared foods.

The top foodservice sectors, by country, based on economic value for the listed year, are shown in TABLE 4.

TABLE 4. Top Foodservice Sectors, by Country

Country	Food Category	Economic Value (US$)	Reference Year
Canada (Statistics Canada 2017c)	Full-service restaurants	20.8 billion	2016
	Limited-service eating places	21.4 billion	2016
	Special foodservices	4.0 billion	2016
Mexico (INEGI 2014a)*	Restaurants (independent, full and limited service)	6.3 billion (P$82 million)	2014
	Restaurants serving traditional fare/ street food	2.6 billion (P$33 million)	2014
	Self-service restaurants	1.9 billion (P$24 million)	2014
United States (Stewart et al. 2004)	Full-service restaurants	165.6 billion	2002
	Quick service	157.3 billion	2002
	Hotels, schools and colleges, event venues, other foodservice establishments	91.3 billion	2002

* INEGI categorizes the top three foodservice sectors in Mexico as follows: restaurants with à la carte or set menu service (code 722511); restaurants serving traditional fare, including tacos and tortas (code 722514); and self-service restaurants (code 722516) (INEGI 2014a).

1.2.2.6 Secondary Markets

Secondary markets cater to customers other than those to whom the product was originally offered. The product can be a surplus of food that was generated for another market, or can be culls or byproducts of food from various points along the food supply chain. For the purpose of this report, the definition of secondary markets is as follows:

Secondary Markets: Market environments for the purpose of selling at a discounted price or redistributing food products from producers, processors, and primary retailers (adapted from ReFED 2017b).

Secondary markets include, but are not limited to, a range of enterprises and organizations that rescue food from the primary food supply chain, and then either supply the food directly to consumers, or, more frequently, send the food to meal programs and food banks. Data are not readily available on the number of enterprises and organizations operating as secondary markets for food, as there is some crossover between the primary and secondary markets. Numbers on food banks and emergency food providers, however, were available for each country, as follows:

- 4,140 food banks in Canada (Food Banks Canada 2016a);
- 63 food banks in Mexico (Interviews M43, M44); and
- 60,500 emergency food providers in the United States (Food Research Action Center 2016).

1.2.2.7 Animal Feed

While animal feed is not counted here as a part of the food supply chain for humans, it is an established end-product from the diversion of food loss and waste (FLW). Animal feed is lower in the food recovery hierarchy than food rescue for human consumption (Section 2.1.2). Its definition is as follows:

Animal Feed: Feed that has content derived from food recovered from surplus food; from wasted food that has undergone treatment and processing; and/or from animal, poultry and fish slaughterhouse discard. Such feed may be mixed with other feed or be fed directly (adapted from ReFED 2017a).

Data on the size of the market using FLW for animal feed are not available, as animal feed manufacturers often use a combination of ingredients, of which only some may come from FLW. However, there is information available on the rendering industry, which processes meat and meat byproducts into stable products, including animal feed ingredients and inedible products (e.g., glycerine for soaps and cosmetics). The National Renderers Association represents 95% of Canada’s and the United States’ independent, integrated rendering facilities and recycles about 30 million tonnes of discarded animal material each year (National Renderers Association 2017). In Mexico, there are about 98 facilities that obtain products from municipally or federally inspected slaughterhouses (Senasica 2016).

1.2.3 Stakeholders Defined

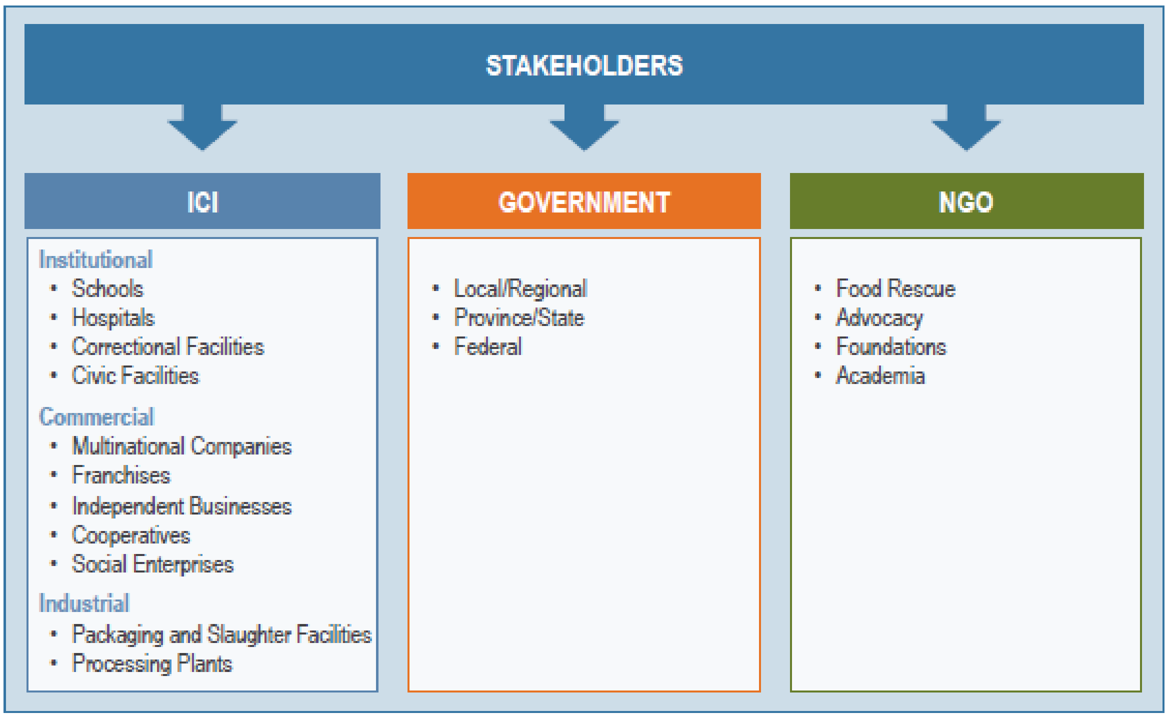
Stakeholders are individuals or organizations that influence decisions or are affected by decisions. Associations typically represent aspects of each stakeholder group. For the purposes of this FLW report, the stakeholders in the food supply chain are defined as listed below. They are also listed in FIGURE 2.

- **ICI (industrial, commercial, and institutional)** is the sector of the commercial and institutional entities processing, preparing, preserving, distributing, and serving or selling foods and beverages, and their respective associations (Wiley Online Library 2016).
- **Government** includes the local, regional, state/provincial and federal departments and agencies with responsibilities related to food and FLW issues. FLW typically involves multiple government departments or agencies, including those concerned with the environment, agriculture, public health and social development.

- **Nongovernmental organizations** (NGOs) are typically nonprofit or voluntary groups of individuals or organizations, formed to provide services or to advocate public policy (Encyclopedia Britannica 2016). NGOs can operate on a local, regional, national or international level. NGOs mentioned in this report include both those that work on food rescue and recovery, as well as charities that support FLW initiatives; advocacy groups; and researchers, both within and outside of academia.

FIGURE 2 lists relevant stakeholders in the food supply chain, across the ICI, government and NGO sectors.

FIGURE 2. Stakeholder Chart



2 Overview of Food Loss and Waste in North America

This section provides a definitional framework for food loss and waste (FLW), reviews the food recovery hierarchy and introduces the issue of FLW, globally and in North America. Quantification of FLW is presented, by country, based on recent reports, along with causes of FLW across the food supply chain.

2.1 Food Loss and Waste: Terms and Definitions

2.1.1 Definitions related to Food Loss and Waste

The definitions of food and inedible parts of food used in this report were adapted from the FLW Accounting and Reporting Standard (FLW Standard) (WRI 2016).

In an effort to establish guidance for quantifying and reporting FLW, the FLW Standard was developed as a voluntary standard by a multi-sectoral group that included the World Resources Institute (WRI), Consumer Goods Forum (CGF), Food and Agricultural Organization of the United Nations (FAO), FUSIONS (Food Use for Social Innovation by Optimizing Waste Prevention Strategies [European Union]), United Nations Environment Programme (UNEP), Waste and Resources Action Programme (WRAP), and World Business Council for Sustainable Development (WBCSD) (WRI 2016).

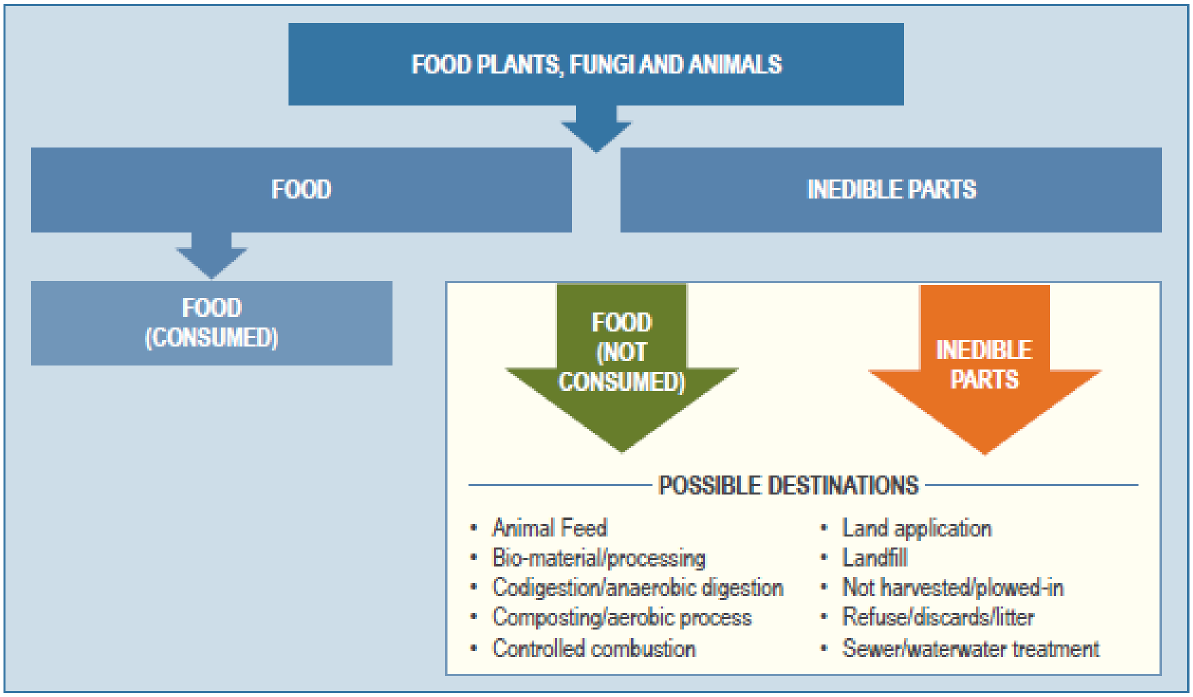
The FLW Standard does not include a standard definition for FLW. Instead, it provides a modular framework that enables entities to use a common set of terms to define what they include when referring to FLW or any similar term. The FLW Standard defines the possible material types (i.e., food and/or associated inedible parts) (WRI 2016, 13), as well as the possible destinations of the material that is removed from the food supply chain (destinations such as animal feed, composting, anaerobic digestion, landfill, controlled combustion, sewer, plowed-in to field) (WRI 2016, 16)—see FIGURE 3.

> **Food (edible)**: Any substance—whether processed, semi-processed or raw—that is intended for human consumption. "Food" includes drink, and any edible substance used in the manufacture, preparation or treatment of food. "Food" also includes the above material when it has spoiled and is therefore no longer fit for human consumption. It does not include cosmetics, tobacco or substances used only as drugs. It does not include processing agents used along the food supply chain—for example, water to clean or cook raw materials in factories or at home (WRI 2016, 15).

> **Inedible Parts (of food)**: Components associated with food that are not intended for human consumption in a particular food supply chain. Examples of inedible parts of food could include bones, rinds and pits/stones. "Inedible parts" does not include packaging. What is considered inedible varies among users (e.g., chicken feet are consumed in some food supply chains but not others). It also changes over time and is influenced by a range of variables, including culture, socio-economic factors, availability, price, technological advances, international trade, and geography (WRI 2016, 15).

A diagram that shows the scope of the FLW Standard and what may be considered "food loss and waste" is provided in FIGURE 3. It highlights two possible material types (food not consumed, and inedible parts) and their possible destinations when exiting the food supply chain.

FIGURE 3. Possible Destinations for Food and Inedible Parts



Source: Adapted from WRI 2016.

Building on the definitions of food and associated inedible parts, the following food loss and waste definitions are used in this report:

Food loss refers to food that is intended for human consumption but, through poor functioning of the food production and supply system, is reduced in quantity or quality.

- Food loss is primarily due to inefficiencies in the food supply chain. Examples include food that rots in the field or in storage because of inadequate management, technology or refrigeration, or food that cannot make it to market because of poor infrastructure and thus goes unconsumed.

Food waste refers to food for human consumption that is discarded (both edible and inedible parts) due to intentional behaviors. "Food waste" often refers to what occurs along the food chain from the retail store through to the point of intended consumption.

- Food waste often occurs by choice, through poor stock management, or through neglect, and includes food that has spoiled, expired, or been left uneaten after preparation.

For the purposes of this report, the term "food loss and waste"—or FLW—is commonly applied. Although the definitions of food loss and food waste vary, significant overlap exists between the two terms. The primary difference is that food loss tends to focus on the upstream stages of the food supply chain (i.e., food production and processing), while efforts to address food waste tend to focus on downstream stages of the food supply chain (i.e., distribution, retail, foodservices and consumers).

FLW can be addressed at all stages of the food supply chain through measures to enhance reduction (e.g., FLW prevention), recovery (e.g., rescuing surplus food to feed people and animals), and recycling (i.e., reducing disposal in landfills via rendering, anaerobic digestion, enhanced composting, or other means).

2.1.2 Terms Used in Food Recovery Hierarchy

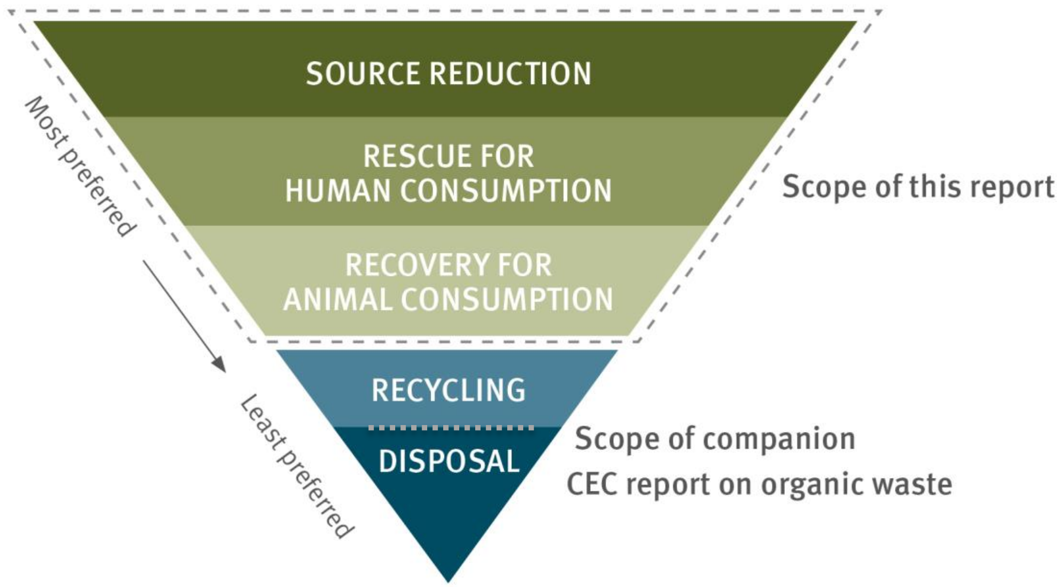
The generally accepted paradigm for FLW management is a hierarchy approach shown in FIGURE 4. The scope of this report only includes reducing at the source, rescuing for human consumption and recovering for animal consumption.

FLW to any destination other than animal feed is considered recycling or disposal. These other destinations are addressed separately in a companion CEC initiative and associated report entitled *Characterization and Management of Organic Waste in North America*.

The tiers of the food recovery hierarchy are defined as follows (adapted from US EPA 2016a; MacRae et al. 2016; Papargyropoulou et al. 2014; Kelly 2014; WRAP 2013):

- **Source Reduction:** Actions to minimize generation of surplus food and prevent avoidable generation of FLW.
- **Rescue for Human Consumption:** Actions to rescue safe and nutritious surplus food for human consumption—receiving, storing, or processing food (with or without payment) that would otherwise be discarded or wasted. The term used in this report to describe food that cannot be used for its originally intended purpose (e.g., sold to primary markets) but is suitable for human consumption is **surplus food**. Food rescued for this human consumption is referred to as **rescued food**, as defined in Section 2.1.1.
- **Recovery for Animal Consumption:** Actions to recover safe and nutritious surplus food for animal feed through receiving, storing, or processing food (with or without payment) which would otherwise be wasted.
- **Recycling:** Actions to recycle food for non-food-related uses—processes such as industrial processing of compounds, including fats and oils; anaerobic digestion; and composting.
- **Disposal:** Actions to dispose of food through controlled and uncontrolled means—primarily landfilling, but also incineration, sewage, open dumping and open burning. The food recovery hierarchy does not recommend the use of uncontrolled disposal options (e.g., open dumping and open burning).

FIGURE 4. Food Recovery Hierarchy



Source: Adapted from EPA 2016a; MacRae et al. 2016; Papargyropoulou et al. 2014; Kelly 2014; WRAP 2013.

2.2 Quantification of Food Loss and Waste

2.2.1 Global

2.2.1.1 Methodology

A diverse range of methodologies has been used to quantify FLW, each with varying advantages and drawbacks (Thyberg and Tonjes 2016). Calculation methodologies include:

- applying waste characterization data (with FLW categories) to total quantities of waste disposed of in municipal solid waste (MSW) facilities;
- analyzing the difference between procurement and sales data;
- aggregating FLW generation data recorded in diaries or surveys/interviews with a representative number of respondents; and
- using food production data combined with a mass flow model or nutritional analysis, to estimate losses from stages of the food supply chain.

The scope of quantification methodologies also varies. Scope parameters that may change between methodologies include:

- stages of the food supply chain;
- sectors (e.g., residential vs. commercial);
- food products; and
- destination of FLW (e.g. landfill vs. composting).

There are significant challenges in quantifying FLW, given that quantification studies use varying methodologies, metrics and definitions of FLW, along with incomplete data sets. In an international literature review, Parfitt et al. (2010) found estimates of FLW vary widely from country to country and much of the data for post-harvest loss in low-income countries was collected prior to 1990. Through global multi-party and multi-stakeholder initiatives, such as the FLW Standard, more recent and accurate data on FLW may become available as countries aim to measure and track FLW in a more consistent manner.

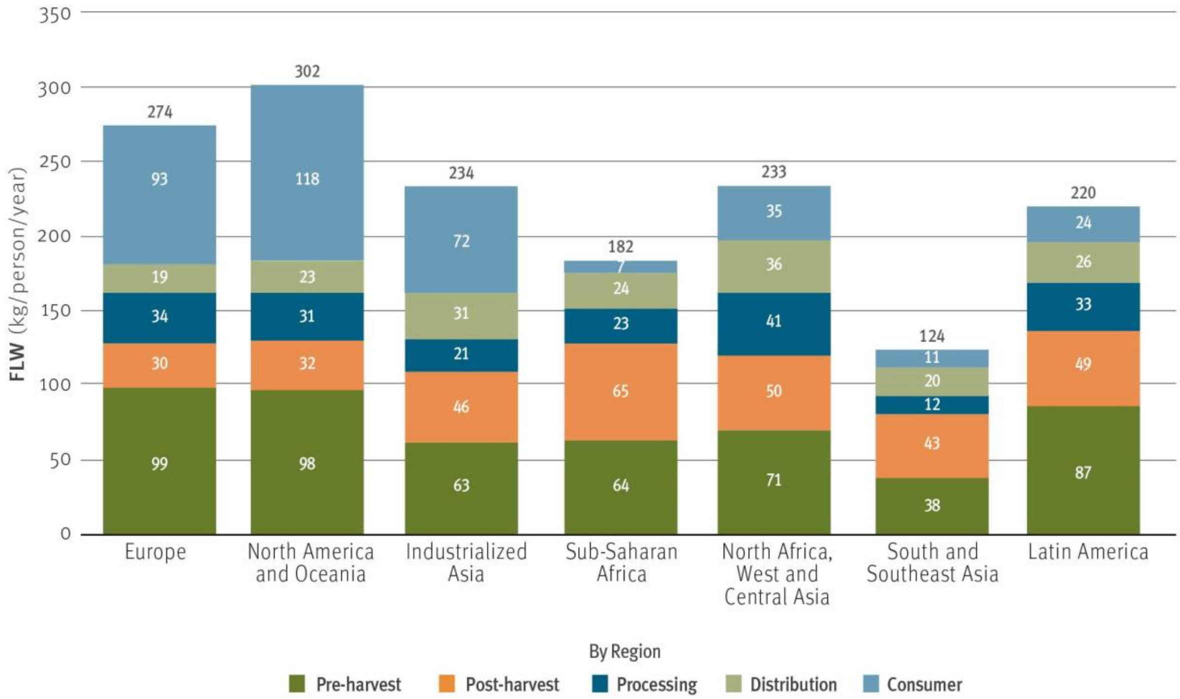
FLW quantification is more prevalent on a local, regional or national level. On a global scale, quantification data are limited. The leading data source on global FLW quantification is the FAO report entitled *Global Food Losses and Food Waste*, by Gustavsson et al. (2011). FAO estimated that one-third of food produced for human consumption is lost or wasted, globally, amounting to approximately 1.3 billion tonnes per year (Gustavsson et al. 2011, v). The FAO's methodology quantified the amount of food produced, by product group (i.e., cereals, roots and tubers, oil crops and pulses [grain legumes such as kidney and pinto beans], fruits and vegetables, meat, fish, dairy). Next, a mass flow model was used to estimate FLW at each step of the product's food supply chain (Gustavsson et al. 2011, 3). The countries of the world were grouped into seven regions (Gustavsson et al. 2011, 4). Conversion factors were also applied to subtract the associated inedible parts, where these factors were available. For meat, milk and egg, allocation and conversion factors were not provided. Therefore, the figures presented by Gustavsson et al. (2011) only represent the "food" component of FLW—with the exception of meat, milk and eggs, where all parts of these products would have been considered edible (i.e., bones and shells not subtracted).

Where there were data gaps, the research team made assumptions and estimations based on FLW data in comparable regions, product groups, and/or stages of the food supply chain (Gustavsson et al. 2011, 3). Furthermore, the FAO used food balance sheets from the year 2007 and sources of loss factors that date as far back as the 1970s. Therefore, the FAO estimates should be interpreted with the understanding that extrapolations were used from a limited data set, and they are meant to be order-of-magnitude estimates.

2.2.1.2 Food Loss and Waste Estimates

FIGURE 5 presents FLW estimates per capita, by region, using the FAO data. More food is generally wasted per person in medium/high-income countries, as defined by the FAO (e.g., Europe, Canada, United States, Oceania, and Industrialized Asia) compared to in low-income countries (e.g., Sub-Saharan Africa, South and Southeast Asia, Latin America (including Mexico), North Africa, West and Central Asia). Also, more FLW generally occurs from the production to distribution stages of the food supply chain in low-income countries, whereas more FLW occurs at the consumer stage in medium/high-income countries.

FIGURE 5. Estimates of Food Loss and Waste, Per Capita, by Region



Note: FLW estimates include only food and exclude inedible parts, as presented in Gustavsson et al. 2011. Includes the market system in distribution (e.g., retail and foodservice).

Source: Adapted from Gustavsson et al. 2011, with updates from Gustavsson et al. 2013.

TABLE 5 presents the breakdown of global FLW, by product type and estimated quantities, along with the definition from the FAO of each product group. These estimates only include food and exclude inedible parts. By weight, fruits and vegetables account for almost half (38%) of FLW globally.

TABLE 5. Share of Global Food Loss and Waste, by Food Category

Food category[1]	FAO Definition	Agricultural Production (million tonnes)[2]	Available Food (million tonnes)[3]	Percent of Total FLW (by weight)	Amount of FLW (million tonnes)
Fruits and vegetables	Oranges and mandarins, lemons and limes, grapefruit, other citrus, bananas, plantains, apples (excl. cider), pineapples, dates, grapes (excl. wine), other fruit, tomatoes, onions, other vegetables	1,520	1,292	38	492
Cereals	Wheat, rice (milled), barley, maize, rye, oats, millet,	2,129	957	24	317

Food category[1]	FAO Definition	Agricultural Production (million tonnes)[2]	Available Food (million tonnes)[3]	Percent of Total FLW (by weight)	Amount of FLW (million tonnes)
	sorghum, other cereals				
Roots and tubers	Potatoes, sweet potatoes, cassava, yams, other roots	700	389	19	244
Milk and Eggs	Milk, eggs	742	622	9	119
Meat	Bovine meat, mutton/goat meat, pig meat, poultry meat, other meat, offal	271	266	5	61
Oilseeds and pulses	Soybeans, groundnuts (shelled), sunflower seeds, rape and mustard seed, cottonseed, coconuts (incl. copra), sesame seed, palm kernels, olives, other oil crops	602	117	3	43
Fish and seafood	Freshwater fish, demersal fish, pelagic fish, other marine fish, crustaceans, other mollusk, cephalopods, other aquatic products, aquatic mammal meat, other aquatic animals, aquatic plants	155	129	1	17
Total[4]		6,055	3,718	100	1,293

[1] Food categories listed here do not represent all categories of food produced globally.
[2] Agricultural production quantities include products not for direct human consumption, such as animal feed.
[3] Available food is the quantity of food for human consumption; this excludes the associated inedible parts of food.
[4] Sum of food categories does not add up to 100% or total, due to rounding of numbers for presentation.

Sources: Adapted from Gustavsson et al. 2013; and from FAO 2017, Food Balance Sheets, for reference year 2007.

2.2.2 North America

2.2.2.1 Methodology

A literature review of FLW quantification methodologies specific to North America identified 11 methodologies (three in Canada, five in Mexico and four in the United States). A summary of the scope and estimates from these methodologies is presented in Table 6. These estimates of FLW, by country, range from six to 13 million tonnes per year in Canada, 12 to 21 million tonnes per year in Mexico and 35 to 60 million tonnes per year in the United States. The estimates of FLW quantities were derived from varying stages of the food supply chain and food types, methodologies, and definitions, as shown in TABLE 6. Although the consumer and food production pre-harvest stages have a significant amount of FLW, they are not included in the scope of this project.

TABLE 6. Comparison of Quantification Methodologies for Food Loss and Waste in North America

Report or Organization	FLW Estimate	Includes Inedible Parts of Food	Food Products Included	Food Supply Chain Stages Included							Destinations Included						Method
				Pre-Harvest	Post-Harvest	Processing	Distribution	Retail	Foodservice	Consumer	Animal Feed	Composting	Anaerobic Digestion	Landfill	Combustion	Sewage	
Canada																	
"$27 Billion" Revisited: The Cost of Canada's Annual Food Waste (Gooch et al. 2014)[1]	30% of food production (no tonnage estimate)	No	All (implied)	√	√	√	√	√	√	√	√	√	√	√	√	√	Used Statistics Canada data (based on USDA food supply and sales data) for FLW from retail and consumers. Collected food loss data from industrial, commercial, and institutional (ICI) stakeholders for other parts of the supply chain.
An Overview of the Canadian Agriculture and Agri-Food System (Agriculture and Agri-Food Canada 2015a)[1]	6 million tonnes/year	No	215 products					√	√[3]	√	√	√	√	√	√	√	Used data on available food in Canada and adjusted for retail, household, cooking and plate loss using the loss-adjusted food availability data series from the USDA to estimate FLW (Buzby et al. 2014).
Food Waste Management and Climate Action: National GHG Reduction Potential (NZWC 2017)[2]	5.6 million tonnes/year	Yes	All (implied)				√	√	√	√		√	√	√	√		Extrapolated waste-composition data and tonnage data from representative municipalities to estimate FLW entering the municipal solid waste management system.

Report or Organization	FLW Estimate	Includes Inedible Parts of Food	Food Products Included	Food Supply Chain Stages Included							Destinations Included						Method
				Pre-Harvest	Post-Harvest	Processing	Distribution	Retail	Foodservice	Consumer	Animal Feed	Composting	Anaerobic Digestion	Landfill	Combustion	Sewage	
Mexico																	
Sedesol (Aguilar Gutiérrez 2013)[1]	12.4 million tonnes/year, equivalent to 37% of the 34 products	No	34 products	√	√	√	√	√	√	√	√	√	√	√	√	√	Used national data from census of food consumption in homes, food production, and imports and exports, to estimate FLW for 34 basic products in the Mexican diet.
Sedesol (MD Consultoría 2015)[1]	19 million tonnes/year (56% agricultural production, <1% processing, 22% distribution, 22% consumer)	No	34 products	√	√	√	√	√	√	√	√	√	√	√	√	√	Used a proprietary methodology developed by a consultant to revise the methodology developed in 2013 by Sedesol to update 23 of the 34 basic products, using the FAO's Latin American factors to estimate FLW.

Report or Organization	FLW Estimate	Includes Inedible Parts of Food	Food Products Included	Food Supply Chain Stages Included							Destinations Included						Method
				Pre-Harvest	Post-Harvest	Processing	Distribution	Retail	Foodservice	Consumer	Animal Feed	Composting	Anaerobic Digestion	Landfill	Combustion	Sewage	
World Bank (Aguilar Gutiérrez 2016)[1]	20.4 million tonnes/year, equivalent to 34.5% of the 79 products	No	79 products	√	√	√	√	√	√	√	√	√	√	√	√	√	Used an updated and improved methodology based on the methodology developed in 2013 by Sedesol, to estimate FLW for 79 products.
IPD (Interview M46)[1]	21 million tonnes/year	No	Not specified	√	√	√	√	√	√	√	√	√	√	√	√	√	Used a revised version of a third-level methodology[4] developed by IPD in 2010. FLW in each stage of the food supply chain was estimated by combining 28 matrices.
Mexico Landfill Gas Model (Stage and Davila 2009)[2]	12 to 45% of landfilled waste (no tonnage estimate)	Yes	All (implied)				√	√	√	√				√			Used waste composition analyses conducted in a number of states, to generate an estimate of FLW within a landfill-gas modeling tool. The tool shows the expected percentage of FLW in landfilled waste.

Report or Organization	FLW Estimate	Includes Inedible Parts of Food	Food Products Included	Food Supply Chain Stages Included							Destinations Included						Method
				Pre-Harvest	Post-Harvest	Processing	Distribution	Retail	Foodservice	Consumer	Animal Feed	Composting	Anaerobic Digestion	Landfill	Combustion	Sewage	
United States																	
The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States (Buzby et al. 2014)[1]	60 million tonnes/year 31% of available food supply	No	215 products					√	√[3]	√	√	√	√	√	√	√	Used a Loss-Adjusted Food Availability (LAFA) data series developed by the USDA, to estimate FLW. LAFA was derived from a combination of primary and secondary data collection, including surveys of retailers, household purchases and household-reported consumption of food.
Advancing Sustainable Materials Management: 2014 Fact Sheet (US EPA 2016c)[2]	35 million tonnes/year	Yes	All (implied)					√	√	√		√		√	√		Used a materials flow model to calculate the amount of FLW disposed of in the MSW stream, based on data from characterization studies.
Food Waste: Tier 1 Assessment (BSR 2012)	54.8 million tonnes/year	Yes	All (implied)			√	√	√	√	√	√	√		√	√		Used waste characterization data from several states, industrial FLW estimates from WRAP 2010, and non-commercial estimates and diversion/rescue/recovery numbers from various ICI-specific studies, to estimate FLW.

Report or Organization	FLW Estimate	Includes Inedible Parts of Food	Food Products Included	Food Supply Chain Stages Included							Destinations Included						Method
				Pre-Harvest	Post-Harvest	Processing	Distribution	Retail	Foodservice	Consumer	Animal Feed	Composting	Anaerobic Digestion	Landfill	Combustion	Sewage	
A Roadmap to Reduce US Food Waste by 20 Percent (ReFED 2016)	56.7 million tonnes/year	Yes	All (implied)	√				√	√	√				√			Used FLW per employee, from ICI-specific studies, US Census data and other secondary sources of published waste generation rates, to estimate FLW. Included farm-level food that is tilled back into the soil.

1. Where not explicitly stated in a report or methodology description, the assumed loss-based methods imply that all FLW destinations are included because the methods estimate quantities leaving the food supply chain but do not specify the exact destination.
2. Where not explicitly stated in a report or methodology description, the assumed loss-based methods using municipal solid-waste data include distribution, retail, foodservice and consumer stages of the food supply chain (Further With Food 2017). All food products are implied to be included.
3. Includes post-consumer foodservice waste only.
4. A first-level methodology is based on gross data—such as FAO waste-food percentages for Latin America, and agri-food production. A second-level methodology takes into consideration specific data at the national level. A third-level methodology compares diverse data sources in order to estimate the quantity of representative agri-food products as they move through the food supply chain and thus improve accuracy of FLW data.

Although there have been various estimates of FLW in each country that cover parts of the food supply chain or specific types of food, a standard quantification methodology has not yet been developed for North America. Therefore, for each country, this report used the FAO methodology for global FLW estimates, as outlined in subsequent sections. According to the regions defined by the FAO (Section 2.2.1), Canada and the United States are included in the North America and Oceania region (Oceania includes Australia and New Zealand), while Mexico is included in Latin America (Gustavsson et al. 2011, 23). Another limitation is that the FAO methodology does not distinguish the FLW in distribution from that in retail or foodservice. Instead, all three of these stages (as defined in this report) are aggregated as distribution. The other food supply chain stages align with those in this report.

As mentioned in Section 2.2.1.1, the general approach of the FAO methodology was to calculate by product type the food production in each country, using food balance sheets and applying regional loss factors to estimate FLW by stage of the food supply chain. A more detailed description of the methodology is presented in Appendix 3.

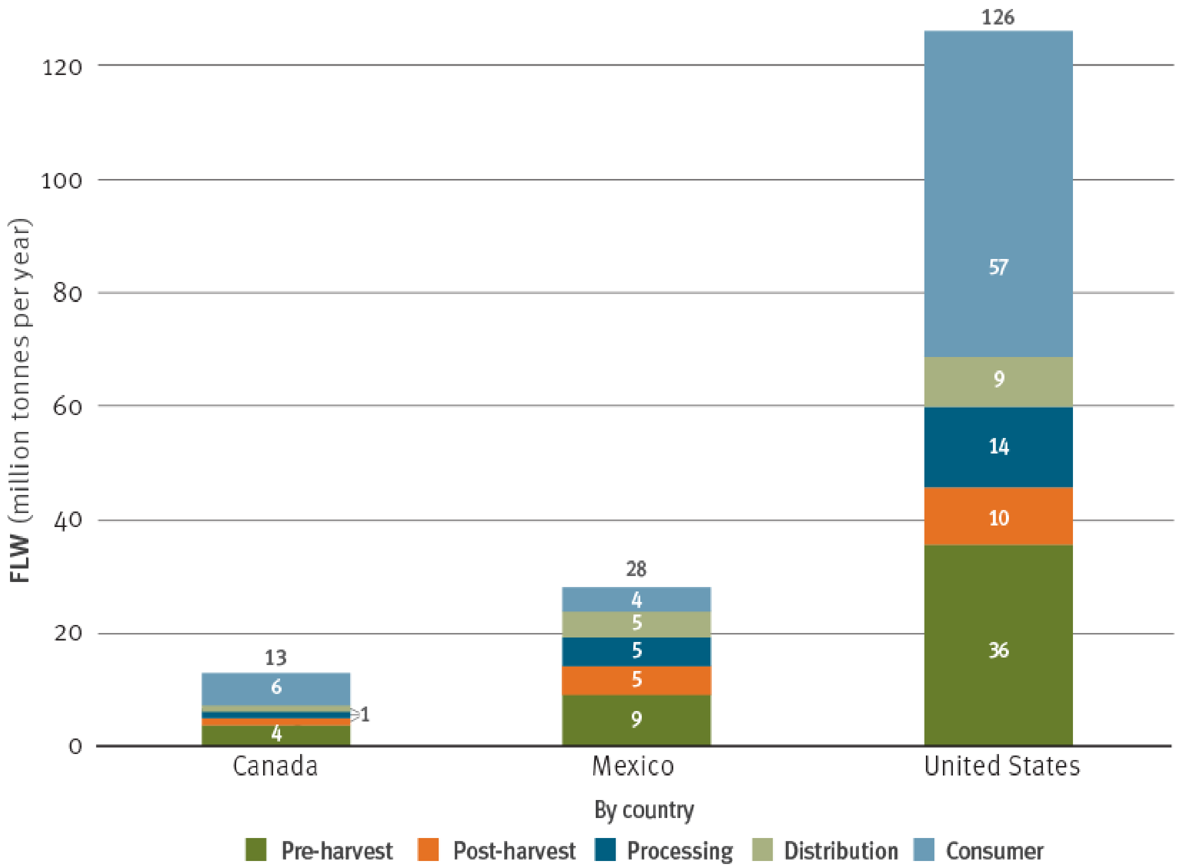
2.2.2.2 Food Loss and Waste Estimates

Using the FAO methodology, but adding back the weight of inedible parts, the total estimated FLW in North America is approximately 168 million tonnes per year. This estimate encompasses all stages of the food supply chain, including the pre-harvest and consumer stages. By country, the estimates are 13 million tonnes in Canada, 28 million tonnes in Mexico and 126 million tonnes in the United States. Data sources are scarce and varied in this emerging area of study, so these numbers should be considered informed estimates. FLW by country is presented in FIGURE 6, and per-capita estimates are included in FIGURE 7.

FAO Methodology Limitations

The FAO methodology is based on geographic regions, not individual countries and not country-specific conditions. Extrapolations and assumptions were used to fill data gaps. Therefore, the estimates should be interpreted with a high degree of uncertainty.

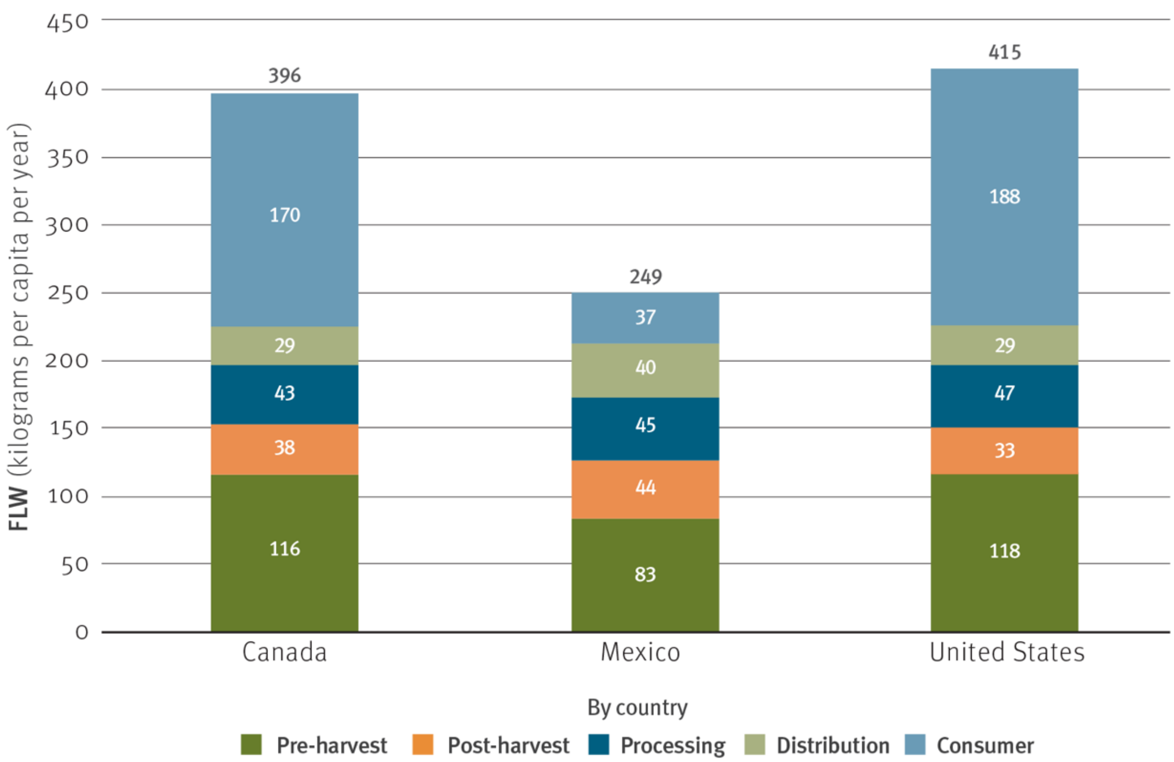
FIGURE 6. Estimates of Food Loss and Waste across the Food Supply Chain in North America



Note: Estimates presented in these graphs encompass all stages of the food supply chain—including the pre-harvest and consumer stages, which are otherwise excluded from the scope of this report. FLW estimates include food (including milk) and inedible parts, based on estimates from FAO Food Balance Sheets and loss factors. FAO data include the market system in distribution (e.g., retail and foodservice).

Source: Adapted from FAO 2017, Food Balance Sheets, for reference year 2007; and from Gustavsson et al. 2013. See Appendix 3.

FIGURE 7. Estimates of Food Loss and Waste, Per Capita, across the Food Supply Chain in North America



Note: Estimates presented in these graphs encompass all stages of the food supply chain—including the pre-harvest and consumer stages, which are otherwise excluded from the scope of this report. FLW estimates include food (including milk) and inedible parts, based on estimates from FAO Food Balance Sheets and loss factors. FAO data include the market system in distribution (e.g., retail and foodservice).

Source: Adapted from FAO 2017, Food Balance Sheets, for reference year 2007; and from Gustavsson et al. 2013. See Appendix 3.

As presented in FIGURE 6, the United States has both the largest population and the largest quantity of FLW of the three North American countries. On a per-capita basis, FLW generation in the United States (415 kilograms/person/year) is similar to that in Canada (396 kilograms/person/year), and much higher than that in Mexico (249 kilograms/person/year).

In Canada and the United States, the consumer stage accounts for the largest share of FLW (43–45%). In Mexico, most FLW occurs in the earlier stages of the food supply chain, with the greatest losses in the pre-harvest food production stage (33%).

A summary, with the percentage estimates of FLW in total and per-capita across the food supply chain, for each country and for North America as a whole, is provided in TABLE 7.

TABLE 7. Estimates of Food Loss and Waste in North America—Food and Inedible Parts

Country	Metric[1]	Agricultural Production[2]	Available Food [3]	Food Loss and Waste, Food and Inedible Parts Amounts presented in brackets reflect FLW estimates for food only, excluding inedible parts					
				Food Production (Pre-Harvest)	**Food Production** (Post-Harvest)	**Processing**	**Distribution** (Includes Retail and Foodservice)	**Consumer**	**Total[4]**
Canada	million tonnes/year	95.7	34.6	3.8 (3.3)	1.3 (1.1)	1.4 (1.3)	1.0 (0.8)	5.6 (5.0)	13.1 (11.5)
	kg/capita	2,902	1,050	116 (100)	38 (34)	43 (38)	29 (24)	170 (152)	396 (349)
	% of FLW	Not applicable (N/A)	N/A	29%	10%	11%	7%	43%	100%
Mexico	million tonnes/year	96.8	76.7	9.4 (7.7)	5.0 (4.3)	5.1 (4.3)	4.6 (4.1)	4.3 (3.7)	28.4 (24.1)
	kg/capita	852	676	83 (68)	44 (38)	45 (38)	40 (36)	37 (33)	249 (213)
	% of FLW	N/A	N/A	33%	18%	18%	16%	15%	100%
United States	million tonnes/year	819.4	344.2	35.8 (30.9)	10.1 (9.1)	14.2 (12.8)	8.9 (7.6)	57.1 (52.0)	126 (112.4)
	kg/capita	2,697	1,133	118 (101)	33 (30)	47 (42)	29 (24)	188 (171)	415 (368)
	% of FLW	N/A	N/A	28%	8%	11%	7%	45%	100%

Country	Metric[1]	Agricultural Production[2]	Available Food [3]	**Food Loss and Waste, Food and Inedible Parts** Amounts presented in brackets reflect FLW estimates for food only, excluding inedible parts					
				Food Production (Pre-Harvest)	**Food Production** (Post-Harvest)	**Processing**	**Distribution** (Includes Retail and Foodservice)	**Consumer**	**Total[4]**
North America	million tonnes/year	1,011.9	455.5	49 (41.9)	16.4 (14.5)	20.7 (18.4)	14.5 (12.5)	67 (60.7)	167.6 (148.0)

[1] FLW estimates are inclusive of all destinations, e.g., animal feed, anaerobic digestion, compost, combustion, landfill and sewage.

[2] Agricultural production quantities include products not grown for direct human consumption, such as commodities used to produce animal feed.

[3] Available food is the quantity of food for human consumption, excluding inedible parts.

[4] Numbers are rounded, so totals may not add up exactly.

Source: Adapted from FAO 2017, Food Balance Sheets, for reference year 2007.

2.2.3 Comparative Greenhouse Gas Savings from Management Approaches to Food Loss and Waste

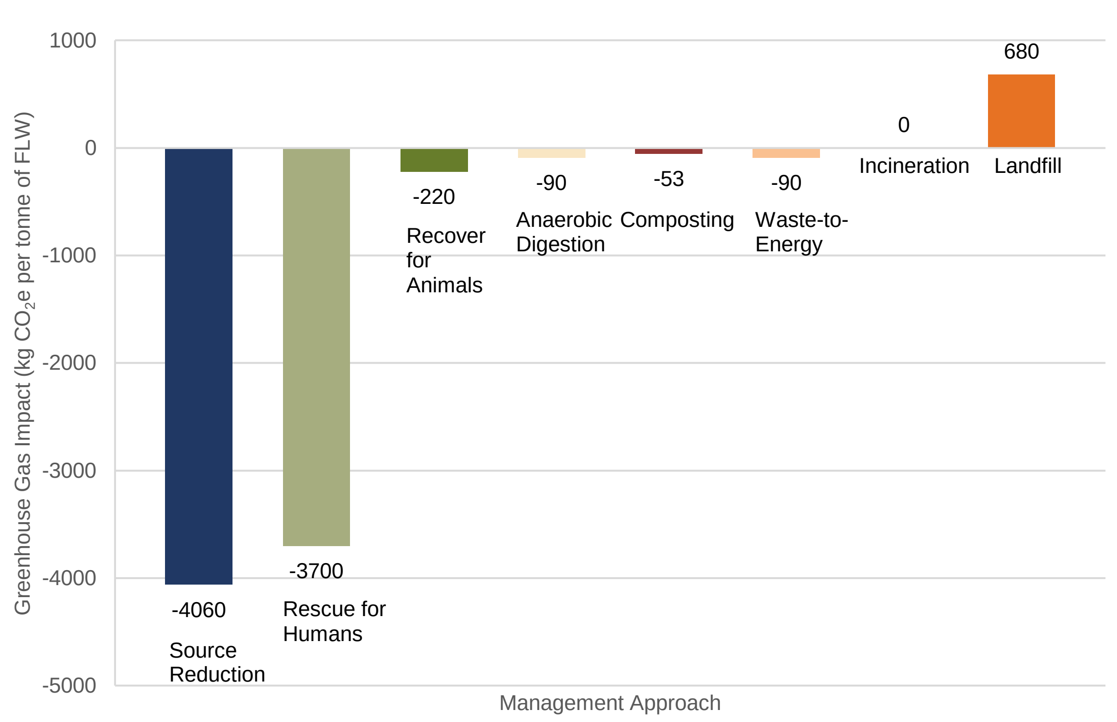
In the context of the food recovery hierarchy presented in FIGURE 4, source reduction and rescue for human consumption are prioritized over recovery for animal consumption, which is in turn preferable to recycling and disposal.

Source reduction has the greatest savings potential for greenhouse gas (GHG) emissions, as more than 80 percent of GHG emissions associated with FLW come from upstream sources (e.g., producing, processing, distributing food) (US EPA 2015a). According to data from the Waste and Resources Action Programme (WRAP) in the United Kingdom (Figure 3), the environmental benefits of rescuing food for human consumption are far greater than those of recovering for animal consumption and therefore make rescue a higher priority.

Rescuing food for human consumption has both environmental and social benefits. The social benefit of rescuing food for human consumption is that it can act as nutritional assistance. The equivalent GHG emissions savings from rescuing food for human consumption are about 20 times higher than those from recovering for animal consumption and about 40 times higher than those from recycling alternatives and disposal (WRAP 2017). In addition to the environmental benefits, rescuing food for human consumption can provide social benefits, such as support for food-insecure people in various communities.

A comparison of the greenhouse gas impacts from the different management approaches to food loss and waste is presented in FIGURE 8.

FIGURE 8. Greenhouse Gas Impacts of Management Approaches to Food Loss and Waste



Note: Data collected by WRAP in 2016, for a tonne of average food waste in the United Kingdom. Includes embedded greenhouse gas emissions.
Source: Adapted from WRAP 2017.

While the food recovery hierarchy provides a clarifying model for managing FLW, approaches from the different tiers of the hierarchy can compete with one another in practice (Interview C3; Mourad 2016, 2). For example, investing in capital-intensive food recycling solutions such as commercial and residential collection programs for composting may disincentivize source reduction, rescue and recovery options, which are higher in the food recovery hierarchy. Additionally, a study from Ohio State University indicated that the visible availability of compost diversion from the landfill removes the effect of consumer education on source reduction of FLW (Crane 2017). When informed that their leftovers would be composted, participants who were educated on the harmful impacts of FLW wasted just as much as uneducated participants. In contrast, "educated" people wasted 77% less food than "uneducated" people, when they thought their leftovers would go to the landfill. This study is another example of the complex relationships that various mitigation strategies have with each other, and the potential unforeseen negative (or positive) side effects.

2.3 Causes of Food Loss and Waste Across the Food Supply Chain

The causes of FLW along each part of the food supply chain, from food production post-harvest to retail and foodservice, are discussed in this section. Approximately 40–60 percent of FLW in North America occurs at the food production pre-harvest and consumer stages. These stages are not included in the scope of the report. However, they have an effect on the post-harvest, processing, distribution, retail and foodservice stages, and vice versa.

The primary causes of FLW in North America along different stages of the food supply chain, from food production post-harvest to foodservice, are presented in TABLE 8. Key players along the food supply chain that can take action on FLW are also included in the table; a more detailed stakeholder list, by country, is provided in Appendix 2. The subsections following the table describe each stage of the food supply chain in more detail, for North America as a whole. Applicable special considerations and notes, by country, are also included, using information from published reports and interviews conducted.

TABLE 8. Causes of Food Loss and Waste, and Key Players that Can Address Them

	Post-Harvest	Processing	Distribution	Retail	Foodservice
Causes of Food Loss and Waste	▪ Grading standards for size and quality ▪ Inaccurate supply-and-demand forecasting ▪ Order cancellations ▪ Employee behavior ▪ Low market prices and lack of markets (especially for second-grade products) ▪ Inadequate sorting ▪ Damage from handling ▪ Spillage and degradation ▪ Inappropriate transportation and storage conditions ▪ Cold-chain (refrigeration during transportation and storage) deficiencies ▪ Labor shortages	▪ Inadequate infrastructure, machinery ▪ Inefficient systems design ▪ Damage during production ▪ Inaccurate supply-and-demand forecasting ▪ Contamination ▪ Trimming and culling ▪ Supply/demand issues ▪ Inconsistent/confusing date labels ▪ Inconsistency in quality of ingredients ▪ Food safety issues ▪ Production line changes ▪ Cold-chain deficiencies ▪ Facility employee behavior	▪ Damage during transport ▪ Inaccurate supply-and-demand forecasting ▪ Cold-chain deficiencies ▪ Rejection of shipments ▪ Poor record keeping ▪ Inappropriate transportation and storage conditions ▪ Incorrect/ineffective packaging ▪ Delays during border inspections ▪ Road infrastructure challenges ▪ Excessive food distribution centralization	▪ Inaccurate supply-and-demand forecasting ▪ Overstocking ▪ Food safety concerns ▪ Inconsistent/confusing date labels ▪ Order minimums and fluctuations in delivery from suppliers ▪ Cold-chain deficiencies ▪ Rejection of shipments ▪ Increasing merchandising standards ▪ Product differentiation ▪ Market over-saturation ▪ Rigid management ▪ Marketing practices	▪ Plate composition ▪ Expansive menu options ▪ Over-serving ▪ Over-preparing ▪ Unexpected demand fluctuations ▪ Preparation mistakes ▪ Improper handling and storage ▪ Rigid management ▪ Facility employee behavior ▪ Food safety concerns ▪ Use of trays ▪ Marketing practices
Key Players That Can Address Causes	▪ Farm owners ▪ Farm workers ▪ Retailers ▪ Processors ▪ Distributors ▪ Food rescue organizations ▪ Service providers (storage, equipment) ▪ Government (various levels)	▪ Facility managers ▪ Facility employees ▪ Retailers ▪ Distributors ▪ Service providers (equipment, process engineers) ▪ Food rescue organizations ▪ Government (various levels)	▪ Facility managers ▪ Farm owners/workers ▪ Facility employees ▪ Service providers (equipment, transport, packaging) ▪ Processors ▪ Retailers and intermediaries ▪ Foodservice ▪ Food rescue organizations ▪ Government (various levels)	▪ Facility managers ▪ Facility employees ▪ Farm owners ▪ Processors ▪ Distributors ▪ Service providers (packaging, technology) ▪ Food rescue organizations ▪ Government (various levels)	▪ Facility owners and managers ▪ Facility employees ▪ Service providers (custodial, delivery, food service) ▪ Distributors ▪ Food rescue organizations ▪ Government (various levels)

Sources: Adapted from Provision Coalition 2014, Blair and Sobal 2006, ReFED 2016, Lipinski et al. 2013, Gunders 2012, Parfitt et al. 2010, and Gustavsson et al. 2011.

2.3.1 Food Production Post-Harvest

2.3.1.1 Regional Overview

Factors that contribute to FLW at this stage of the food chain are applicable to plant products as well as livestock and seafood and include:

- damage;
- order cancellation;
- rigid contract terms;
- variable market prices /high labor costs;
- cosmetic expectations; and
- lack of storage infrastructure.

If there is an unanticipated large harvest, low market demand, or order cancellation, food producers usually lack access to additional storage, handling or processing infrastructure to keep products fresh or preserve them prior to sale (Interviews U19, C8). Due to inadequate facilities, products can be damaged from mishandling or can spoil due to lack of cold-chain management. Furthermore, since market prices are set based on supply and demand, if there is an oversupply of a product, it may lower prices below a profitable margin for producers, making saving the product uneconomical.

Quality standards (e.g., specific color, size and shape) are established by national-level governments, but more-stringent cosmetic standards are set by the retail, distribution and processing sectors (Buzby et al. 2014; Gooch et al. 2014). Cosmetic standards prevalent in Canada and the United States also affect post-harvest FLW in Mexico because a significant portion of Mexico's agricultural exports is destined for Canadian and American markets. For example, of the US$26.6 billion in agricultural exports from Mexico, US$22.9 billion were from sales to the United States (Thompson 2016).

Although second-grade products can be used by the food processing sector, market prices for food destined for food processing are typically far below fresh-market prices (Schneider 2013). Farm workers are typically paid by the amount harvested and need to work at a fast pace to earn a living wage, even for fresh market produce. If prices per piece are too low, harvesting second-grade products is not worthwhile since the higher-grade products yield a higher price for the same amount of labor.

Specific trends in each country are highlighted below.

2.3.1.2 Canada

The Provision Coalition found, in 2014, fruits and vegetables, meat, and grains were the top three "hot spots" for FLW in the field, post-harvest, and in processing and packaging, while fruits and vegetables, seafood, and meat were the top three "hot spots" for FLW in distribution (Uzea et al. 2014).

In Canada, grading standards are set in the Fresh Fruit and Vegetable Regulations for a number of fresh fruit and vegetable products (Government of Canada 2011). The purpose of the Fresh Fruit and Vegetable Regulations, according to the Canadian Food Inspection Agency, is to "regulate the safety, grading, packing and marketing of fresh fruits and vegetables produced domestically and imported into Canada" (Canadian Food Inspection Agency 2015a). These grading standards apply to fresh fruits and vegetables imported into Canada or traded between one province and another. When solely traded within a province, produce must meet the applicable provincial grade requirements, if any. Produce labeled with a Canada-grade name must at all times meet federal grade requirements. The percentage of produce grown in Canada that is second-grade (safe to eat but does not meet the first-grade standards) has not been quantified.

Fluctuations in market prices, especially for crops that compete with imports, cause FLW in Canada (Interviews C8, C27). Compared to those in the United States and Mexico, Canadian fruit and vegetable prices are generally higher, although profit margins are very slim (Interviews C8, C27). While there have been campaigns to encourage Canadians to purchase Canadian-grown products, they often come at a premium price (Interview C7). Sometimes, surplus stocks of produce from other countries are sold in Canada well below market prices, making it challenging for Canadian farmers to compete, resulting in their produce going to waste (Interview C7). Federal grade standards for 30 fresh fruits and vegetables aim to prevent this.

2.3.1.3 Mexico

According to the Ministry of Social Development (*Secretaría de Desarrollo Social*—Sedesol), 36 percent of food was lost in the field and 20 percent was lost in storage, in 2015.

Post-harvest FLW in Mexico is an especially important issue amongst lower-income farmers, who have 10–40 percent of their crops lost in the field (Ramírez 2014, 14). The primary reasons for this FLW are inefficient handling, limited access to technology, and minimal technical assistance on how to most effectively store harvested crops and manage humidity (e.g., with hermetic technology) in storage (García-Lara and Bergvinson 2007, 182–183). The high humidity and hot temperatures experienced in many parts of Mexico exacerbate this problem. For example, maize crops are one of the most important agricultural products in Mexico and there is approximately 40 percent more post-harvest food loss of maize occurring in tropical and subtropical regions than in dryer and cooler regions, which only experience 1 percent waste (García-Lara and Bergvinson 2007, 182–183).

Maize, a staple grain in the Mexican diet, is typically handled post-harvest by using traditional techniques of drying and storage, such as sun-drying, mixing grains with ash and sand, smoking grains, and storing without threshing (Hernández et al. n.d.). These traditional techniques do not protect the grain against pest infestation and humidity, and therefore cause post-harvest FLW (García-Lara and Bergvinson 2007, 186). Typical best management practices often include hermetic metallic silos, plastic bags and containers, and flexible canvas tents (Ramírez 2014, 17).

While better techniques are available, lack of resources for farmers and lack of awareness on their part prevent implementation of better storing technologies and handling practices for grains and seeds (Interview M3). The lack of financial mechanisms to support farmers' acquisition and installation of silos is a major cause of low uptake (Interview M3). When subsidies for the purchase of the silos were eliminated, demand for silos receded (Interview M3).

Various research institutions in Mexico have been studying other causes of post-harvest food loss during the storing stage, and solutions to reduce this occurrence. Examples of innovative techniques include the use of inert substances (e.g., diatom dust) and of native plants that act as natural repellents against pests around storage areas (Silverio and Bergvinson 2007, 186).

Another cause of FLW specific to Mexico is the inadequate amount of cold-storage infrastructure, both on farms and in packinghouses. Complicated and strict regulations for "general storage warehouses" often prevent ICI stakeholders from obtaining permits, and this combined with higher cost outlay contributes to the lack of cold storage (*Almacén General de Depósito*)[4] (Cámara de Diputados 2014; Wageningen UR and Sagarpa 2014, 24).

[4] General Storage Warehouses are defined by the General Law of Organizations and Auxiliary Credit Activities, Article 11 (DOF 2014). They store, preserve, and manage the distribution or trade of products under the warehouse's custody. Warehouses also do value-added processing, as well as the packaging of stored merchandise, with the aim of increasing value without overly modifying the original product. General Storage Warehouses are subject to specific regulations when they are used to store agriculture, livestock and fishery products, including the Law of Rural Sustainable Development.

With respect to Mexican produce destined for export, another major contributor to FLW is price fluctuation. This is particularly evident in the border region of Santa Cruz County, in southern Arizona, which sees vast quantities of fruits and vegetables arriving from Mexico. Due to price fluctuations, entire truckloads of this produce can be discarded in landfills (Hughes 2015).

2.3.1.4 United States

On average, approximately 7 percent (by area) of croplands in the United States are not harvested each year (Kantor et al. 1997 in NRDC 2012), but this figure varies widely and can be as high as 50 percent (Bloom 2010 in NRDC 2012). Another study determined that an average of 10 percent of produce grown in the United States is second grade and wasted (ReFED 2016). This produce is safe for human consumption, but does not meet the grading standards set by the USDA (e.g., specific color, size, shape) (USDA 2016a).

Traditional practices such as gleaning are being revived at independently-owned farms, in order to support food banks, increase food security and reduce FLW (Domenic et al. 2015). However, commercial farms generally do not allow this practice, due to concerns with liability (Interview U3), even though Good Samaritan laws exist in the United States that indemnify donors of food, provided the food is unadulterated, not spoiled, and fit for human consumption, and the donor did not intend to injure or cause death to the recipient of the food or otherwise act with reckless disregard for the safety of others. This indicates more communications and clarity may be needed regarding food donation laws.

2.3.2 Processing

2.3.2.1 Regional Overview

FLW in the food processing sector is caused by a number of factors, including:

- trimming for consistency;
- order cancellation;
- customer demand;
- overproduction;
- high cost of investment;
- improper labeling;
- misshapen products; and
- contamination.

Trimming at the processing stage to create a product uniform in shape and size is a source of FLW (Gustavsson et al. 2011, 12), but it may reduce later waste from trimming by the consumer at home. As well, pre-cut produce, while having created more waste at the processing stage, may appeal to consumers or foodservice establishments, which may reduce FLW at those stages of the food supply chain (Gunders 2012, 9). Also, processing plants have more potential uses for the byproducts, compared to what a consumer at home may have (Gunders 2012, Interview C39).

In parallel to farmers' planting extra crops to hedge against uncertainty, food processors typically overproduce food products to guarantee retail orders are fulfilled (MacRae et al. 2016). When excess product cannot be sold, it may be wasted. This dynamic may be further exacerbated by order changes and last-minute cancellations (MacRae et al. 2016).

While food processors aim to minimize food falling short of retail or wholesale standards, products often fall below quality or safety standards and require disposal. During common quality-control practices, a few units of flawed product can result in an entire batch being removed from processing, in order to mitigate concerns.

Specific trends in each country are highlighted below.

2.3.2.2 Canada

The food processing industry in Canada is large and extensive. It is the largest manufacturing employer in the country, accounting for 2 percent of GDP, and supplies 75 percent of processed food and beverage products available in Canada (Agriculture and Agri-Food Canada 2016a). Statistics Canada estimates that there are over 5,700 facilities, most of which are located in Ontario (35.1 percent), Quebec (24.7 percent), British Columbia (16.1 percent), and Alberta (8.1 percent) (Statistics Canada 2016). It is also estimated that 18 percent of total FLW in Canada results from processing and packaging (Uzea et al. 2014). Moreover, most of the food lost during this stage is a result of risk management and of spoilage due to inadequate packaging and processing (Uzea et al. 2014). Additionally, FLW in the processing industry predominantly consists of grain products, seafood, meat, beverages, and dairy products (Uzea et al. 2014).

2.3.2.3 Mexico

According to IPD (2014), key causes of FLW at the processing level are a result of lack of trained staff and lack of certification processes. The minimal interview participation by industry associations and the limited feedback from them indicated low prioritization of current FLW-focused initiatives. Just six of 12 food processor associations agreed to an interview and only one of the six interviewed provided information specific to FLW. There is very limited information on the amount and causes of FLW from the processing sector in Mexico. Most research conducted on the food processing sector is unpublished, conducted by academic institutions or government organizations, and focused on process optimization to reduce waste in general or identified byproducts that can be used in secondary markets.

2.3.2.4 United States

Trimming, overproduction, product and packaging damage and technical malfunctions were identified as causes of FLW in food processing in the United States (Gunders 2012; BSR 2014). Due to the limited number of manufacturing facilities, large volumes of FLW are generated per facility, which incentivizes recycling versus reduction, rescue or recovery (BSR 2014). Two other causes of FLW are production-line and product-line changes (e.g., changes to ingredients, discontinued flavors), which generally result in large quantities of similar products that end up as FLW because they cannot be used for another purpose.

2.3.3 Distribution

2.3.3.1 Regional Overview

FLW during distribution is caused by a number of factors, including:

- lack of cold-chain infrastructure,
- damage and spoilage, and
- delays during border inspections.

When shipping perishable food products, the transportation industry faces tradeoffs between time and costs; the more perishable the food product, the shorter the timeframe available for transportation from production point to packing, processing, retail, or foodservice and finally the consumer, and the higher the likelihood of damage or spoilage (Mena et al. 2011). Distributors often carefully balance storage life and shelf life of highly perishable foods such as produce, meats and dairy against the higher transportation costs associated with road or air shipping instead of rail. Finding the optimum balance is essential to avoiding FLW.

In North America, most food is produced far from urban centers, resulting in vast travel distances that pose significant challenges. Damage, spoilage or quality deterioration during the shipment of fresh goods, especially during cold, long hauls, can result in retailers' rejecting of loads or culling of pallets (MacRae et al. 2016). Problems can also occur if shipments are held back at checkpoints or border crossings by customs (Gunders 2012, 9).

Ultimately, maintaining the cold chain presents the most significant opportunity for extending storage life and avoiding FLW. Cold-chain continuity issues are further exacerbated in hot humid regions where cold-chain infrastructure is limited or aging, such as in Mexico (Gustavsson 2011, 8).

Although the causes of FLW described above refer mostly to distribution in the primary food supply chain, they also affect the secondary markets, particularly food rescue efforts by NGOs (Interviews U36, C33, C37). Small and medium-size food rescue organizations often lack funding to make upfront capital investment in cooling and transportation infrastructure. As a result, rescued food may spoil before it is delivered to the end-user.

Specific trends in each country are highlighted below.

2.3.3.2 Canada

In Canada, FLW during distribution most commonly occurs in perishable goods such as fruits, vegetables, seafood, and meat (Uzea et al. 2013). As most of the country's population resides in southern Canada, food transportation and distribution utilizes a combination of rail and trucking, in cold or non-cold trucks (Government of Canada 2012). This perishable-food transportation system relies on the use of cooling and freezing units, a significant percentage of which are older units (Garnett 2008). While there is always room for improvement, food distribution to most of the Canadian population is reliable and contributes to a relatively small proportion (3 percent) of overall FLW (Uzea et al. 2013).

Distribution presents a bigger challenge in vast parts of the country where northern and remote communities are based; these areas are mostly uninhabited and inhospitably remote (World Bank 2015b; Prentice 2016). In northern communities particularly, overland transportation by truck or rail is difficult, if not impossible, for most of the year, marine transport is impossible during winter months and air transport viability is subject to changing weather conditions (Prentice 2016). Air transport remains the most reliable option for delivering critical supplies to people, but it is accompanied by staggering operational costs, resulting in food prices and other essential-goods prices that are 2–3 times higher than in the rest of Canada (Prentice 2016). While the government has set up the Nutrition North Canada initiative to subsidize the cost of food for northern residents, chronic challenges continue to face food distributors that service Canada's remote communities (Government of Canada 2016c).

2.3.3.3 Mexico

Inadequate road, rail, storage and transportation infrastructure causes increases in food transportation time and costs, while diminishing the quality of perishable food at its destination (Sagarpa 2010, 166). For example, although rail transport of imports to Mexico is the most economical way to ship food, the transit times are much longer than those of other modes of transportation (Vijay 2013, 16).

Inadequate cold-chain infrastructure is also a key contributor to FLW. The majority of the trucks of the most common types used for food transportation do not have any type of cooling: only 35 percent of tractor-trailer trucks have, and only 19 percent of closed-box trucks (Sagarpa 2010, 165). Only 7 percent of the total vehicles involved in food transportation accommodate cold transport.

Besides infrastructure challenges in distribution, the centralization of wholesalers in urban centers such as Mexico City also contributes to FLW. The Central Supply Market (Ceda), located in Mexico City, is responsible for trading 30 percent of the national production of food (Fundación UNAM 2013). Approximately 70–80 percent of the national production of fish and seafood is traded in *La Nueva Viga* (a wholesale fish market), also in Mexico City (Interview M56). Crops from rural areas are transported to the Mexico City Central Supply Market for packing and distribution. They are then sent back to rural areas, often where the crops are grown, for retail. This additional transportation not only results in spoilage due to the extra transit time, but also contributes to higher greenhouse gas emissions.

Lastly, as Mexico is a large exporter of perishable food products (e.g., vegetables and fruits), delays at border crossings cause FLW and require inter-country collaboration to mitigate. Exporters typically add 10 percent to their loads, to take into account expected damage during transportation (Interview M65), but border inspections can interrupt the cold chain and jeopardize entire shipments of perishable foods (Wageningen UR and Sagarpa 2014, 12). For example, Mexican importers may abandon loads at the border crossing between Mexico and the United States. Loads may also be delayed due to lack of knowledge of the legal requirements and corresponding paperwork needed by importers (USDA 2016d). For imports, improved border infrastructure and greater efficiency in processing shipments could reduce spoilage or quality loss. More-efficient importer and export processes could improve the country's capacity to meet legal requirements and procedures, which could reduce FLW (Interview M76).

2.3.3.4 United States

The distribution sector in the United States is by far the biggest and most diverse of all those in the three North American countries, with more than 15,000 companies operating fleets of trucks and warehouses and offering customers more than 10,000 food and non-food items (Food Safety Magazine 2009). Due to the number of products and stakeholders operating in this sector, inaccurate predictions may lead to surplus products with no markets, and such products eventually become waste.

More than half of fresh produce in the United States is grown in California (Parsons 2014), which has a large agricultural sector and a long growing season. Produce from California is shipped across the United States, and the long distances create high potential for damage and spoilage.

2.3.4 Retail

2.3.4.1 Regional Overview

FLW in the retail sector is caused by a number of factors, including:

- adversity to change stocking practices or product sizes,
- overstocking,
- misinterpretation of food safety standards,
- customer demands,
- date labeling,
- unreliable cold storage, and
- modification or cancellation of orders.

This subsection describes the causes of FLW that occurs directly at the retail level, and does not cover the impact of FLW in other stages of the supply chain. Food retailers have a disproportionately large influence on FLW generation, both upstream and downstream of the food supply chain, due to their exceptional buying power (Richards et al. 2013). For example, charging lower prices in order to move product or challenge competing retailers can influence consumers to buy more than they are likely to consume (Patel 2012).

A typical supermarket's targeted shrink (percentage of products that are not sold) ranges from 3 percent to 7 percent of everything purchased for sale (MacRae et al. 2016). Shrink includes both food and non-food products, as well as losses from theft, spoilage, damage and overstocked items. While shrink does include theft, accounting errors and other factors that do not result in FLW, shrink can be used as a proxy for FLW at the retail level (Buzby et al. 2016).

Most of the FLW in retail operations is from perishable products, as they spoil or expire (e.g., produce, baked goods, meat, seafood, and, increasingly, ready-to-go foods). Rejection of second-grade fruits and vegetables and of damaged goods is also a significant cause of FLW in the North American retail sector (Otten et al. 2016; Reyes 2015; Gunders 2012). Retailers cull fruits and vegetables that do not meet the specified size, shape and color. It is also common to remove goods in damaged packaging, whether these goods are still edible or not, due to perceived customer preferences (Otten et al. 2016). However, not all of the culls end up being wasted. Some second-grade product is sold at discounted prices or re-used in ready-to-go meals. However, a ready-to-go meal has a very short (one-to-two-day) shelf life. Store owners want to ensure ready-made foods remain fresh and stocked until store closing and typically cull these products at the end of the day (Gunders 2012, 10).

Another cause of FLW that has emerged is that stores stock an increasingly diverse number of products. From 2003 to 2013, the average products per store increased from 30,000 to 50,000 (Gill 2013). With a larger number of products to manage, there is a higher risk of inaccurate forecasting of supply and demand. The communications channels between retailers and food supply chain stakeholders are often less than optimal, which leads to misinformed or uninformed decisions related to managing fluctuations in supply and demand (Value Chain Management Centre 2012, 8).

In addition to the issues with supply and demand, retailers have a perception that consumers will increase purchase quantities when selecting items from a full display. The resulting overstocking of products can lead to product damage from the greater amount of handling and culling of unsold products exceeding best-before dates (Gunders 2012, 10; Sealed Air 2015; Otten et al. 2016). Although retailers in some jurisdictions are able to stock products past best-before dates, it is not a common practice, and in some regions it is prohibited by law.

Specific trends in each country are highlighted below.

2.3.4.2 Canada

Fruits and vegetables are the most frequently wasted foods, due to their high perishability and relatively low value, and they account for 26 percent of the waste from the retail sector (Agriculture and Agri-Food Canada 2015a). One special consideration in Canada is that the CFIA stipulates that best-before dates provide an indication of freshness and potential shelf life and does not stipulate that food must be discarded after the durable-life date (Canadian Food Inspection Agency 2014). Despite this clarification, retailers still commonly cull products that are close to their best-before dates (Interviews C41, M71). However, some of this food is saved through donations to food rescue organizations (Interviews C37, C41).

2.3.4.3 Mexico

A key difference in the Mexican retail sector that sets it apart from Canada and the United States is the distribution of food retailers. Modern retailers, such as grocery stores, department stores and convenience stores similar to those in Canada and the United States, are generally located in cities. In more-rural or sparsely populated areas, traditional food retailers, such as small grocery stores, niche stores (retailers that only sell one or two types of items) and street vendors, dominate. Municipal markets and *tianguis*—open-air roadside markets that occur on designated days, across various locations—are also common types of retail settings (INEGI 2010).

Modern retailers have more access to resources that help reduce FLW, such as more-efficient inventory management systems, standardized practices, and access to credit to upgrade infrastructure such as refrigerators and storage space. Traditional retailers do not have these resources and as a result, generate more FLW (Sagarpa 2010, 157–159). In 2008, 96 percent of total sales from the retail sector were registered in communities with fewer than 15,000 inhabitants (Sagarpa 2010, 157–159), where there are few modern retailers.

2.3.4.4 United States

The top four grocery retailers (Wal-Mart, Kroger, Safeway and Publix) make up nearly 40 percent of the market in the United States (USDA ERS 2016b). This agglomeration has important impacts on the generation of FLW at the retail level, as well as upstream and downstream effects. Due to their key position in the food chain between farm and consumer, retailers often dictate food standards to both producers and consumers, which results in large amounts of waste from culling and other "quality control" practices (Richards et al. 2013). Furthermore, the concentration of 40 percent of the market in four retailers results in an immense amount of power for those companies to set operational and policy trends and standards across the food chain (USDA ERS 2016b; Richards et al. 2013).

The United States does not have legislative guidelines for standardized date labels, like Canada and Mexico do, which adds to confusion for retailers about when products need to be taken off shelves, especially in states where the sale of products past their best-before date is prohibited by law. There are 21 states with laws that restrict retailers from selling some foods past their best-before date—these foods are mostly perishables, such as dairy, eggs, meat and seafood (ReFED 2017c). There are currently ten different date labels that can be used on food products in the United States, such as "Sell By," "Use By," "Expires On," or "Better if Used By" (Grocery Manufacturers Association 2017). The Grocery Manufacturers Association and the Food Marketing Institute created a voluntary standard in 2017 to address these issues, which may help reduce FLW caused by date labels.

2.3.5 Foodservice

2.3.5.1 Regional Overview

FLW in the foodservice sector is caused by a number of factors, including:

- poor food preparation and training techniques;
- overfilling dishes;
- large plates and trays;
- difficulty assessing demand;
- variety in menu options;
- all-you-care-to-eat buffets;
- hygiene rules; and
- lack of cold storage.

There are two types of FLW in the foodservice sector—pre-consumer and post-consumer. Pre-consumer waste occurs in the kitchen as part of the food preparation process, such as trimming, as well as because of overproduction of food prepared but not served (Otten et al. 2016). Post-consumer FLW is food served to a customer but not eaten; it is a significant portion of FLW in the foodservice sector (Gunders 2012, 11; Otten et al. 2016). In the United States, approximately 17 percent of food in meals is left uneaten by diners (Bloom 2010, 125). Data are not available for Canada or Mexico.

Overproduction is a primary cause of pre-consumer waste because it is challenging to match supply and demand for specific menu items. It is a common practice for foodservice establishments to project anticipated demand based on sales trends, but foodservice establishments generally err on the side of overproducing so that they can avoid disappointing customers by running out of menu choices.

Another cause of pre-consumer FLW that is more applicable to large franchises is strict policies on inventory management and holding times, to maintain quality standards for freshness (Gunders 2012, 11). These policies prevent store managers from re-using food prepared but not sold (Gunders 2012, 11).

The primary causes of post-consumer food waste are large serving sizes and unwanted side dishes (e.g., bread, fries) (Massow 2013; Vyhnak 2014; Sanchez 2008). Across North America, average serving sizes have increased between 40 and 400 percent over the past few decades (Massow 2013; Vyhnak 2014; Sanchez 2008; Gunders 2012; Young and Nestle 2012; Nielsen and Popkin 2003). Increasing portion size infers increased value for consumers. The additional cost to increase portion sizes is generally lower compared to the additional profit from larger portion sizes, which creates the impetus for employing “super-sizing” strategies. Since 1960, the size of plates has increased by 36 percent, as has the size of bowls and glasses (Wansink and Van Ittersum 2007). The increases in plate and bowl sizes correlates to increases in portion sizes. The average pizza slice increased in calories by 70 percent, from 1982 to 2002 (Gunders 2012). Portions offered by fast-food chains are two to five times the size of the portion originally offered when the chains began, and additionally, portion sizes can range from two to eight times the size of serving recommended by USDA or FDA (Young and Nestle 2003).

In institutional settings, one cause of post-consumer FLW is that the food served may not align with consumer preferences for a meal, especially when the food served is a set meal (e.g., in hospitals, nursing homes, and schools). Studies have shown that 12–50 percent of food goes uneaten in these environments across the United States (Buzby and Guthrie 2002; Lamilla n.d.; Smith and Cunningham-Sabo 2013). Another cause of FLW in institutional settings is the use of trays for serving food. Trays can encourage customers to take enough food to fill the tray, even if they do not intend to eat all of it.

Post-consumer FLW also encompasses served food not touched by the consumer. Depending on the local health authority, food that has been served or displayed may or may not be re-used (e.g., bread baskets, food trays on a buffet line), depending on whether the food has met the temperature and time controls set by the authority (Interview C17; Gunders 2012).

Specific trends in each country are highlighted below.

2.3.5.2 Canada

Despite the prevalence of franchises, the foodservice industry in Canada is mostly (approximately 60 percent) represented by independent industrial, commercial and institutional (ICI) stakeholders (Uzea et al. 2014). These small and medium-size enterprises (SME) tend to lack the resources and/or the information necessary to provide ongoing staff training and invest in accurate inventory management systems, in order to optimize forecasting (Statistics Canada 2014).

2.3.5.3 Mexico

As of 2014, there were 515,059 foodservice establishments in Mexico (Canirac 2014).[5] Restaurants in Mexico are categorized in two types: traditional, and organized. Traditional restaurants generally offer

[5] For additional information, see Censos Economicos 2014, Instituto Nacional de Estadística y Geografía, <www.inegi.org.mx/est/contenidos/proyectos/ce/ce2014/>, consulted 30 June 2017. Information may not be directly comparable, due to varying methodologies.

traditional Mexican cuisine and are independent businesses; they account for approximately 96 percent of the foodservice establishments and represent 68 percent of sales of the foodservice sector. Examples include taco places (*taquerías*); small, family-owned outlets (*fondas*); seafood places (*ostionerías*); snack outlets (*merenderos*); and takeaway shops (*cocinas económicas*). Organized restaurants account for approximately 4 percent of the foodservice establishments and represent 32 percent of sales of the foodservice sector. They are chains and larger establishments and serve a wider variety of international food. They include fast-food establishments, coffee shops, specialty dining places and both full-service and informal restaurants (Alatriste 2014).

With regard to pre-consumer FLW, a large portion (36 percent) of traditional restaurants in Mexico consists of smaller diners called *fondas* (Alatriste 2014). The FLW generated in *fondas* is minimal compared to that in other ICI establishments (Interview M09). Some of the reasons for this are:

- customers are usually frequent clients who know the menu, service, flavor and portions;
- the weekly menu is constant, as well as the average size of meal served, so inventory is better managed to avoid FLW;
- portions are adequate (just enough) and usually there is nothing left on plates;
- bread and tortillas are not automatically served; and
- employees are allowed to take home most types of pre-consumer kitchen leftovers—except soups since they are hard to transport without spilling (Interview M9).

Post-consumer FLW in Mexico is less of an issue, as restaurant customers usually take home the remaining food left on the plate—except at exclusive or elite full-service restaurants and during business meals, because it is not considered proper etiquette (Interview M75).

2.3.5.4 United States

The United States has seen a shift in how food is prepared and eaten. Increasingly, people are eating away from the home at restaurants or buying take-home meals from foodservice operators. In 2014, Americans spent 50 percent of their food dollars away from home (USDA ERS 2016b). In 1990, only 43 percent of food dollars were spent away from home. Due to this shift in eating habits, food waste within the foodservice sector has also increased. In addition, thanks to longer workdays or commutes, people dedicate less time to meals. This dynamic results in more demand for quick, ready-to-eat, convenience foods.

All-you-care-to-eat restaurants are common in most parts of the United States and typically have large amounts of plate waste from people taking more food than they can eat (i.e., over-portioning). There is usually no penalty for customers who leave food uneaten and customers are generally inclined to fill their plates (Wansink and van Ittersum 2006).

3 Source Reduction of Food Loss and Waste

The research team reviewed published definitions of source reduction of food loss and waste (FLW) (Appendix 1) to inform how this term is defined for this report.

Based on this review, source reduction of FLW is defined herein as:

> Actions to minimize generation of surplus food and prevent avoidable generation of FLW.

This section identifies key benefits for stakeholders from reducing FLW and identifies challenges along the food supply chain, as well as reviews current approaches to FLW reduction in Canada, Mexico and the United States.

3.1 Building the Case for Source Reduction of Food Loss and Waste

Investing in FLW reduction strategies has the potential to significantly benefit stakeholders across the food supply chain, as outlined by stakeholder groups in this section.

3.1.1 Industrial, Commercial and Institutional

Due to an increasing global demand for food and to the associated pressure on the environment to meet that need, conventional food practices in the industrial, commercial and institutional (ICI) sector are unlikely to be sustainable (Messenger 2015). For the North American food industry, there is a threat that not addressing FLW could result in food scarcity when attempting to feed growing populations (Gunders 2012, 19). Food producers and distributors have expanding options for where they sell products, so poor practices may tarnish sector relationships and could drive them to sell elsewhere (Gunders 2012). For the North American food industry to stay competitive in a global market amidst increasing demand for socially and environmentally responsible practices (e.g., in Europe), there is a need to maintain practices such as initiatives for reduction of FLW, to ensure a stable supply of food. ICI stakeholders have the opportunity to leverage resources collectively (e.g., through associations) to promote FLW reduction practices.

At an individual operational level, FLW reduction has the potential for increased sales, operational savings and lower carbon taxation. A recent report shows that companies engaging in FLW reduction efforts gained US$14 in savings for every US$1 spent (Hanson and Mitchell 2017, 2). This 14:1 median benefit-to-cost ratio was determined by assessing over 1,200 companies around the world in a report prepared by Hanson and Mitchell on behalf of Champions 12.3. Addressing FLW can have a direct economic benefit to ICI stakeholders through cost savings from: lower purchasing requirements; increasing efficiency; better inventory management; and decreased disposal and organics-processing costs (Papargyropoulou et al. 2014, 109). FLW reduction may increase revenue, not just from higher profit margins due to lower operational costs but also from increased brand recognition for socially and environmentally responsible practices (Segre 2012, in Value Chain Management International 2012, 10). Furthermore, in the market of value-added food products, there is untapped potential from second-grade ingredients or byproducts. By developing new and innovative products from what would have otherwise been waste, the ICI sector could benefit from opening up additional markets and increasing revenue, all while decreasing FLW.

3.1.2 Government

Reducing FLW represents an opportunity for governments to reduce greenhouse gas (GHG) emissions from the production, processing and distribution of food that ends up being wasted. In addition to reducing GHG emissions, there are added environmental and socio-economic benefits, such as economic prosperity, food security, natural resource conservation, habitat loss mitigation, biodiversity protection, and reduction of pollution and waste. Governments can also benefit monetarily from a more efficient and sustainable food supply chain, and by reducing the burden on waste management infrastructure to handle, process and dispose of FLW. Mitigation of greenhouse gas emissions, through reduction of FLW, and the added supply-chain efficiencies that result from reducing packaging are further discussed in Section 6.2 and Case Study 33.

One example of an FLW reduction program that has benefited government is the United Kingdom's national campaign to reduce food waste. The hallmark of this initiative was the Love Food Hate Waste media outreach, which informed households about the quantity of food they wasted, the financial cost of that waste, and tangible steps they can take to reduce waste. As a result, from 2007 to 2012, the UK was able to reduce household food waste by 21 percent, a reduction of 1.1 million tonnes (Hanson and Mitchell 2017). The government and its partners in the ICI sector achieved a benefit-to-cost ratio of 250:1, when accounting for direct savings from the initiative as well as the savings to UK households (Hanson and Mitchell 2017). This means that for every US$1 spent, there was US$250 in resulting benefits (Hanson and Mitchell 2017). Beyond the financial case, the reduction in food waste had positive environmental ramifications, as it was equivalent to removing 1.4 million passenger vehicles from the road, saving one billion cubic meters of water, and making unnecessary the use of a total of 430,000 hectares of land for food production (Hanson and Mitchell 2017).

3.1.3 Nongovernmental Organizations

NGOs working on FLW issues generally also have other environmental or social mandates, such as increasing sustainable food production, ending hunger, conserving natural resources, increasing biodiversity, and decreasing GHG emissions. Since FLW reduction can result in positive environmental and social impacts, it can help NGOs achieve their other mandates as well as further their advocacy efforts. For example, Food Secure Canada has been advocating for a national food policy that adopts a holistic and systemic view of food and sustainable food production (Interviews C3, C30). Reduction of FLW is one way to work toward the broader vision of sustainable food production.

For food rescue NGOs, FLW reduction initiatives can save on staff and financial resources for sorting and disposing of spoiled or unusable donations. If food products are better managed at other parts of the food supply chain to reduce spoilage, damage and overproduction, this will increase the quality of donations because the food would arrive in a better state.

3.2 Challenges to Source Reduction of Food Loss and Waste

Although FLW reduction is at the top of the food recovery hierarchy and should be prioritized above other initiatives, it can be perceived as the most challenging type of approach for stakeholders in the food supply chain to adopt, because they do not have the foundational knowledge to take action. In addition, source reduction is a less tangible approach if the stakeholder is not already measuring and tracking. Similarly to other material or product supply chains, the food supply chain is designed to maximize throughput so as to optimize sales of products. Since food is traded as a product, reducing the amount of FLW generated can be challenging, given the importance of balancing production and consumption. In the ICI sector, the financial importance of reducing FLW is not seen as a major issue, due to the lack of awareness about the quantity of food being wasted.

An overview of challenges to reducing FLW along the food supply chain is presented in TABLE 9. These challenges have been determined through an extensive literature review, stakeholder engagement, and interview results.

TABLE 9. Challenges to Source Reduction of Food Loss and Waste in North America

Stakeholder	Challenges to Reducing Food Loss and Waste
Food Production Post-Harvest	- Grading standards - Limited storage space - Market fluctuations - Lack of cold-chain management
Processing	- FLW is not seen as an economic issue - Market fluctuations - Grading standards
Distribution	- Lack of cold-chain management - Lack of storage space
Retail	- Grading standards - Best-before dates - Lack of cold-chain management - Limited shelf/storage space
Foodservice	- Best-before dates - FLW is not seen as an economic issue
NGOs	- Lack of staff and funding
Government	- Lack of collaboration between departments - Lack of staff and funding

3.3 Current Approaches to Source Reduction of Food Loss and Waste

There are different approaches that have emerged to address the challenges surrounding FLW source reduction, as outlined in Section 3.2.

The methodology used to select approaches for this section consisted of a combination of literature review and interviews. Initially, a list of approaches was developed based on the recommendations from reports and conference proceedings on FLW, including the following:

- *A Roadmap to Reduce U.S. Food Waste by 20 Percent* (ReFED 2016)
- *Global Food Losses and Food Waste* (Gustavsson et al. 2011)
- *Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill* (Gunders 2012)
- *Best Practices & Emerging Solutions Guide* (Food Waste Reduction Alliance 2015)
- *Developing an Industry Led Approach to Addressing Food Waste in Canada* (Provision Coalition 2014)
- Agri Logistics National Program (*Programa Nacional de Agrologística –Diagnóstico*) (Wageningen UR and Sagarpa 2014)
- Integral model of the labor formalization based on the improvement of productivity (*Modelo Integral de la Formalización Laboral con Base en la Mejora de la Productividad*) (Rodríguez 2015)
- Challenges and opportunities of the Mexican Agri-Food System for the next 20 years (*Retos y Oportunidades del Sistema Agroalimentario en México en los próximos 20 años*) (Sagarpa 2010)

- Evolution of cold transport in Mexico (*Evolución de la flota de autotransporte refrigerado en México*) (Morales 2016)
- North American Workshop on Food Waste Reduction and Recovery (CEC 2017b)
- *Recycling, recovering and preventing "food waste": Competing solutions for food systems sustainability in the United States and France* (Mourad 2016)

Common themes emerging from the above literature are presented in TABLE 10. Each approach includes a description, root causes of FLW addressed, and the food supply stages involved, with the more directly involved stages indicated in bold. Initiatives identified as promising solutions across multiple literature sources were researched in more detail. Interviews for each country were conducted with key stakeholders (academia, different levels of government, ICI associations, foodservice, NGOs) throughout the food supply chain to identify which of these approaches would be most promising.

TABLE 10. Approaches to Source Reduction of Food Loss and Waste

Approach	Description	Causes of FLW Addressed by Approach	Stages of Food Supply Chain Involved*
1. Reducing Portion Sizes	In foodservice settings, reducing portion sizes as a way to reduce plate waste, either through serving smaller portions or making operational changes that encourage customers to take less food.	- Over-preparing - Over-serving - Plate composition - Use of trays	- **Foodservice**
2. Increasing Marketability of Produce	Accepting and integrating second-grade produce into retail settings, typically sold at a discounted rate.	- Grading requirements for size and quality as set by retail and/or government - Inaccurate forecasting of supply and demand - Increasing merchandising standards - Rejection of shipments	- **Post-Harvest** - Processing - Distribution - **Retail** - Foodservice
3. Standardizing Date Labels	Collaborating among stakeholders to standardize date labels so they are clear and consistent, in order to reduce confusion at all stages of the food supply chain.	- Inaccurate forecasting of supply and demand - Inconsistent/confusing date labels - Food safety concerns	- **Processing** - **Distribution** - **Retail** - Foodservice
4. Implementing Packaging Adjustments	Collaborating among processors, packagers, retail and foodservice to improve shelf life, using both packaging and sizing (e.g., flexible pack sizes, to meet customer demands) and technology (e.g., intelligent packaging).	- Damage during transport - Inconsistent/confusing date labels - Cold-chain deficiencies - Food safety concerns - Over-purchasing	- Post-Harvest - **Processing** - **Distribution** - **Retail** - Foodservice
5. Improving Cold-Chain Management	Improving or upgrading infrastructure, such as trucks, cold rooms and warehouses, to	- Rejection of shipments due to spoilage - Cold-chain deficiencies	- **Post-Harvest** - Processing

Approach	Description	Causes of FLW Addressed by Approach	Stages of Food Supply Chain Involved*
	maintain appropriate food temperatures during transportation.	- Inappropriate storage conditions (e.g., temperature not regulated or does not meet sanitary standards)	- **Distribution** - **Retail** - Foodservice
6. Expanding Value-Added Processing	Extending the usable life of food through processing into shelf-stable products, including processing byproducts into food products through innovative technologies.	- Low market prices and lack of markets for second-grade products - Damage from handling - Inaccurate forecasting of supply and demand - Cold-chain deficiencies - Trimming and culling	- Post-Harvest - **Processing**
7. Increasing Operational Efficiencies and Technology in Manufacturing	Optimizing manufacturing lines through better control of production processes, to reduce downtimes and to increase yields in trimming/butchering.	- Inadequate infrastructure, machinery - Inefficient design of systems - Inconsistency in quality of ingredients - Production-line changes - Employee behavior	- **Processing**
8. Limiting Number of Menu/Product Options	Reduce the number of choices in a retail/foodservice setting, especially for the same types of products, to reduce the amount of surplus or spoiled stock.	- Expansive menu options - Unexpected demand fluctuations - Order minimums and delivery fluctuations from suppliers - Market over-saturation	- **Retail** - **Foodservice**
9. Developing Alternative Purchasing Models	Using purchasing models that decrease the amount of time that products are on display, to maintain freshness and reduce shrink. Examples include virtual merchandising and grocery delivery services.	- Overstocking - Order minimums, and delivery fluctuations by suppliers - Excessive centralization of food distribution - Inappropriate transportation and storage conditions	- **Distribution** - **Retail**
10. Optimizing Ingredient Use	In foodservice settings, creating daily specials or special offers, to use up excess products, cuts and trimmings or food that is getting closer to its use-by date. This can also include planning menus that maximize the number of common ingredients in order to decrease	- Employee behavior - Food safety concerns - Improper handling and storage - Expansive menu options	- **Foodservice**

Approach	Description	Causes of FLW Addressed by Approach	Stages of Food Supply Chain Involved*
	the amount of inventory that needs to be managed.		

Six of the ten approaches to source reduction of FLW identified in Table 10 are described in further detail in Section 3.4. Moreover, Section 3.4 links these approaches to the causes of FLW across the food supply chain introduced in Section 2.3. The six approaches that are described in detail are not of higher priority; rather, they have a higher frequency of citation in literature and reference by survey respondents. The last four approaches were identified in literature sources, but were not as prominent nor described in detail. Therefore, they are included in Table 10 to acknowledge additional approaches that could be used for source reduction of FLW. Further research on them has not been conducted for this report.

TABLE 11 links the six approaches to the challenges introduced in Section 3.2; a direct link means the approach specifically addresses a challenge, whereas an indirect link presents an opportunity to address the challenge, depending on how the approach is implemented.

TABLE 11. **Linking Challenges and Approaches to Source Reduction of Food Loss and Waste**

Challenge	Approach					
	1. Reducing Portion Sizes	**2. Increasing Marketability of Produce**	**3. Standardizing Date Labels**	**4. Packaging Adjustments**	**5. Improving Cold-Chain Management**	**6. Value-Added Processing**
Grading standards	N/A (Not applicable)	Direct—provides the opportunity to bring a broader range of items into the market	N/A	N/A	N/A	Indirect—presents opportunity to create another revenue stream to help offset costs
Market fluctuations	N/A	Indirect—creates opportunity to use surplus	Indirect—enables ability to use surplus stock even after best-before date	Indirect—increases shelf life, to store products until they are needed	Indirect—increases product shelf life so they can be kept fresh until needed for markets	Indirect—as above
Best-before date uncertainty	N/A	N/A	Direct—addresses date issues	N/A	N/A	N/A
Lack of cold-chain management	N/A	N/A	N/A	N/A	Direct—addresses direct concern	Direct—reduces need for cold storage by processing products
Limited shelf/ storage space	N/A	N/A	Indirect—clarifies dates, which enables more efficient inventory management to better use space	Indirect—helps to better manage shelf space, items more protected for stacking	N/A	Direct—reduces space required for storing surplus
FLW is not seen as an economic issue	Indirect—creates a structural change to adjust behaviors	Indirect—markets off-grade items and increases awareness	Indirect—clarifies date labels and increases awareness regarding FLW	Indirect—creates a structural change for portion sizing to adjust behaviors	Indirect—reduces FLW and related costs through infrastructure improvements	N/A

3.4 Approaches to Source Reduction of Food Loss and Waste

This section identifies key approaches for FLW source reduction in Canada, Mexico and the United States from the perspective of the food industry, government, and NGOs. For each approach, current trends, challenges and considerations for implementation are described. Also included with each approach are examples of initiatives in each country, as applicable. For select approaches, case studies are included in Section 9 of this report.

Key considerations for implementation were grouped into four categories, defined as follows:

- Costs: Additional costs needed to implement approach (capital and operating)
- Savings: Financial savings as a result of implementing this approach (capital and operating)
- Time to implement: Length of time needed to operationalize change
- Anticipated level of stakeholder support: The level of buy-in that stakeholders will have for this approach.

The rating scales presented in TABLE 12 are used to rate the potential of each of the key considerations determined for six approaches to source reduction of FLW, which are described in the following sections and presented in Tables 14 to 20.

TABLE 12. Ratings Applied to Key Considerations for Implementing Source Reduction

Key Consideration	Rating Scale
Costs	Low = low annual cost Medium = medium annual cost High = high annual cost
Savings	High = high cost savings Medium = medium cost savings Low = low cost savings
Time to implement	Short = implementable in the short term Medium = implementable in the medium term Long = implementable in the long term
Anticipated level of stakeholder support	Low = low support by stakeholders Medium = medium support by stakeholders High = high support by stakeholders

3.4.1 Approach 1: Reducing Portion Sizes

3.4.1.1 Description

A growing body of evidence links smaller portion sizes to reduction in post-consumer FLW. In a study that tested the willingness of customers to downsize their meal to smaller portions, those that chose smaller portions had a 20-percent reduction, by weight, of the amount of food left on the plate at the end of the meal (Schwartz 2012). In another study, more than 25 percent of customers were willing to purchase reduced portion items and those that chose the smaller portions reduced FLW by more than 30 percent (Berkowitz et al. 2014). In a self-serve setting, one study found that customers using smaller plates reduced portions by up to 20 percent, but did not notice that they took a smaller portion (Wansink and van Ittersum 2006).

With such strong evidence for reducing portion sizes, operational changes can be made to reduce over-portioning and reduce plate waste: offering customers a portion that they can finish or encouraging customers to take only what they want to eat. These adjustments seek to tackle various unconscious factors that contribute to over-portioning, such as the subconscious desire to have a sufficiently full plate or tray. Examples of strategies that can be used are described in more detail in TABLE 13.

TABLE 13. Strategies for Approach 1: Reducing Portion Sizes

Strategy	Description
Smaller Portions on Menus	Offering a range of portion sizes on a menu to appeal to a range of customer portion preferences, especially those who do not want a full portion (Berkowitz et al. 2014). Another approach is encouraging share plates (menu items meant to be shared), usually served in appetizer-sized portions (Porter 2014). Examples of smaller portions are snacks, lunch or half-portions (Gunders 2012).
Using Smaller Plates	Serving food on smaller plates to reduce over-serving and over-consumption, while ensuring customers feel they have received value for their money because their plate is "full" to an aesthetically pleasing level (Wansink and van Ittersum 2006).
Trayless Dining	Removing trays in various self-serve or institutional foodservice operations to encourage customers to carefully select preferred food items. This results in reduction in portion size (and in FLW), as it is harder to carry multiple dishes without a tray, and people feel satisfied with the quantity of food because it is no longer dwarfed by the size of the tray (Aramark 2008; Kim and Morawski 2012; Knapp 2009).
Financial Incentives for Clean Plates	For all-you-care-to-eat settings, customers pay surcharges for uneaten food (Food 2008; Baldwin and Rustemeyer 2014) or receive discounts if they clean their plate (Sullivan 2013). These types of practices encourage diners to only order or take portions of food that they can eat, and err on the side of caution by underserving themselves. If customers are still hungry, they have the option of adding more food to their plate later.

3.4.1.2 Trends

Restaurants across North America are increasingly changing their menus to offer a variety of meal portions. Restaurants and restaurant associations are open to new trends to capture new customers concerned about issues like health and FLW. Furthermore, obesity and diabetes are on the rise across North America and there is increasing pressure to address these problems in the foodservice sector, in part through smaller portions and healthier food options.

In the United States, the National Restaurant Association annually publishes a culinary forecast list entitled "What's Hot." Items on the What's Hot 2016 list included half-portions/ smaller portions for a lower price, and grazing (small plate sharing /snacking ,instead of traditional meals) (NRA 2015). Small plates are becoming more mainstream in restaurants and are no longer limited to higher-end dining establishments (Porter 2014). This trend is partially driven by foodservice industry attempts to enhance the dining experience and to encourage customers to share food and have more interaction while eating (Porter 2014). However, while some approaches, such as smaller portion sizes, have already been a common offering on menus, they are still generally priced in a way that incentivizes purchasing larger portions (Gunders 2012).

Although examples of foodservice establishments using smaller plates have not been published, the National Restaurant Association, in the United States, has identified smaller plates as a strategy for restaurants to serve smaller portions for health reasons, while keeping consumers satisfied (NRA n.d.). Tactics that were identified include smaller bowls and plates and taller, narrower glasses (NRA n.d.).

In self-serve settings like cafeterias and all-you-care-to-eat restaurants, trayless dining has been found to be effective at reducing FLW. Across Canadian and American colleges and universities, trayless dining is increasing in popularity as cafeterias are recognized as high generators of FLW (Interviews C19, U1). Schools using trayless dining reduced waste by 25–40 percent (Kim and Morawski 2012; Aramark 2008; Knapp 2009). Trayless dining for large institutions is an attractive option since revenue is already collected from student fees for typical college meal plans. Therefore, trayless dining is an effective cost control measure to reduce the amount of resources wasted on food that is not consumed (Levin 2012).

Although trayless dining has already been adopted widely in institutions, it has not been as common for private businesses such as self-serve buffet restaurants and cafeterias (ReFED 2016). However, this approach can be applied in commercial settings. An additional benefit to trayless dining is the savings in staff time, energy, and water for cleaning trays. The estimated amount of water conserved by these programs is approximately 0.75 liter of water per tray (Davis 2008).

Specific trends regarding portion size, trayless dining and selective dining in each country are highlighted below.

Canada: Portions in Canada are generally smaller than in the United States, so the amount of change needed is proportionately lower when it comes to reducing portion sizes. For example, Canadians consume an average of 3,590 calories per day versus Americans, who consume 3,770 calories per day (Melvin 2008).

Aramark and Sodexo, the two largest foodservice companies in Canada for post-secondary institutions are adopting trayless dining as a measure to reduce FLW (University Affairs Canada 2015). For example, Aramark introduced trayless dining at Dalhousie University, in Halifax, Nova Scotia, in 2008 and, based on its success, has continued to roll out the program, resulting in trayless dining having become standard practice in Aramark school cafeterias. Additionally, Aramark has now introduced smaller dinner plates (nine-inch plates) in all locations, to replace the typical-size dinner plate (Interview C19).

Mexico: In smaller diners called *fondas*, clients may ask for half-portions even if they are not included on the menu. Awareness of avoiding FLW and ordering smaller portions is more common among customers who frequent these types of eateries. Elderly people are often more conscious about asking for portions they can actually consume (Interviews M75, M64). It is increasingly common for other restaurants to offer half-portions, provide the possibility to share plates, or propose a variety of side dishes to choose from so that the food ordered by the consumer is eaten and not wasted (CMR 2016; Interview M9). In some schools, such as Colegio Madrid, individual food items are sold in single-serving portions and no combos or side choices are pre-established (Interview M64). By implementing these practices, foodservice businesses encourage consumers to reduce plate waste.

There is little information on trayless dining in Mexico, where buffets are more common only in hotels and full-service restaurants. While there appears to be an opportunity for FLW reduction through greater adoption of trayless dining, there are currently no published reports on FLW reduction initiatives in these settings.

United States: Trayless dining has become more popular in colleges, increasing from approximately 42 percent in 2009 (Foderaro 2009) to 75 percent of colleges and universities tracked by the Sustainable Endowments Institute in 2013 (Rogers 2013). ReFED (2016) estimated that if foodservice companies downsize their plates they could reduce FLW by up to 162,000 tonnes annually, saving the ICI sector US$382 million. If they used trayless dining, they could reduce FLW by up to 75,000 tonnes per year, representing an economic value of US$187 million (ReFED 2016).

3.4.1.3 Challenges and Special Considerations

The foodservice sector faces a number of challenges to changing its operations to reduce FLW by reducing portion sizes. Competition, especially among casual-dining restaurants and fast-food services, has driven the need to provide new food choices, and offering larger portions is an easier business decision. Foodservice establishments cater to the demands of customers and while there has been an increase in demand for healthier foods, this has not translated to an increased demand for smaller portions (Gase 2014).

Large portions offer more “value,” or “value for money” to customers, so foodservice stakeholders that use large portions as a value proposition may be concerned that if portion sizes are reduced, they would offer less value to the customer and the service would be less competitive (Riis 2014). Another challenge is that smaller portions may increase emphasis on food quality rather than on food value, as healthier, organic or locally-sourced ingredients are usually sold at premium prices (Interview C18). Therefore, to increase food quality, the ingredient cost will be higher, which needs to be either absorbed in decreasing revenue or passed on to the customer, which may negatively affect profitability (Riis 2014; S20).

Challenges to trayless dining predominantly involve accessibility issues. For example, customers may not be able to carry their whole meal, especially if there are obstacles such as doors, stairs, or long distances. Another disadvantage is that it may cause congestion in the serving area and increase the risk of spills if customers need to get food multiple times, especially if it is a “market-style” format, where food is served at multiple stations (Foderaro 2009). Therefore, when moving to trayless dining, retrofits may be required to make it easier to open doors, navigate stairs or walk long distances while carrying plates, cutlery and other items (ReFED 2016).

Some further criticisms gathered from current users of trayless dining systems in universities and colleges are the following:

- Trays are more convenient.
- Trays allow students to make one trip for drinks and plates of food.
- Trayless dining results in greater mess at the tables.

Beyond accessibility, adopting trayless dining often requires an adjustment period, during which customers adapt to the new system. In university/college settings, introducing the change at the beginning of the term, rather than mid-way through, was found to be helpful.

Specific challenges and considerations in each country are highlighted below.

Canada: In Canada, foodservice profit margins average 4.5 percent, which is relatively low and thus does not leave a lot of room for decisions that may affect these profit margins (Agriculture and Agri-Food Canada 2015). ICI stakeholders would generally choose to err on the side of continuing with the status quo, versus trying newer or innovative approaches.

Approximately 75 percent of Canadian colleges and universities contract out their food procurement and preparation to foodservice companies (University Affairs Canada 2015). These contracts dictate how food is served, so even if a foodservice company wishes to adopt trayless dining, it can only do so if the college or university puts it into the contract.

Mexico: Although larger restaurant corporations in Mexico are working to implement programs to address FLW issues, including waste reduction and diversion (CMR 2015), attention to plate waste is low. Generally, small and medium-sized enterprises are less inclined to pursue more menu customization or similar options, since these changes are associated with added complexity and reduced revenue. However, many small and medium-sized enterprises already offer simpler, half-portion options and allow employees to take home food left over from the kitchen, resulting in less FLW generated overall compared to that of larger enterprises (Interview M9, M75).

FLW reduction practices in buffet and cafeteria-dining settings have not been well-documented in published literature and information on this topic was not readily available through interviews conducted for this project.

United States: Americans have the highest per-capita consumption of food in the world, and overeating is a norm, so reducing portion sizes is expected to be even more of a challenge than it is in other North American countries (Melvin 2008). Trayless dining has already been adopted by a number of colleges, but it is unclear whether there will be more uptake of this approach by other cafeteria/buffet–style institutions. TABLE 14 presents summaries of the key considerations for foodservice establishments, in implementing these approaches.

TABLE 14. Key Considerations for Implementing Approach 1: Reducing Portion Sizes

Key Considerations	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium to High**	Profit margin for foodservice establishments is already low, and smaller portions typically raise unit costs for production. Any operational changes (e.g., removing trays, using smaller plates) incur capital costs for retrofitting or new materials. For ICI stakeholders, mitigating the one-time retrofitting cost and the potentially higher operational costs is critical to remaining profitable.
Savings (financial savings as a result)	**High**	Financial savings for foodservice establishments include reduced staff time for food preparation; lower food-procurement costs; and less money spent on disposal of FLW. There are also savings on utilities, such as energy and water in food preparation, and water use in cleaning (e.g., trays).
Time to Implement (length of time needed to operationalize change)	**Medium**	Some operational changes, such as offering half-portions, can be implemented quickly, especially in independently owned operations (e.g., through a menu change). Other approaches may take more capital investment or training of staff, and thus take more time. For contracted foodservices or franchise chains, there may be contract obligations or chain-wide standards that need to change, which may take more time.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	The foodservice sector may not be convinced that reducing FLW through reducing portion sizes and changing ordering practices will appeal to customers. This could be mitigated through other incentives or through awareness campaigns that demonstrate successful case studies.

3.4.1.4 Example Initiatives

Canada:

- Forage Restaurant in Vancouver switched to small-plate dining and decreased plate waste by 50–60 percent (Chavich 2015).

- Aberdeen Memorial Hospital, in New Glasgow, Nova Scotia, discovered that most patients left behind their desserts. Using this information, the hospital eliminated this from the menu, resulting in a reduction of post-consumer FLW (Mior 2009).
- Neighbourhood Group of Companies reduced the size of its desserts, resulting in less waste and more sales (Interview C17). This initiative is further discussed in Case Study 1.
- Dalhousie University, in Halifax, Nova Scotia, introduced trayless dining in all four of the residence dining halls, which not only cut back on water consumption during cleaning, but also reduced FLW by 25–30 percent (Wright 2007; Smulders 2008). This initiative is further discussed in Case Study 2.
- Queen’s University and the University of Alberta Augustana Campus saw similar results to Dalhousie’s project (21-percent and 30-percent plate-waste reduction, respectively) (Queen's University 2011; University of Alberta 2014).

Mexico:

- The Mexican Diabetes Association launched a campaign called Challenge Restaurants for Health (*Reto Restaurantes Por La Salud*), in which 20 restaurants are testing offering smaller portions and half meals (Asociación Mexicana de Diabetes 2016).
- Le Bon Gout Restaurant offers half portions to customers when requested and observed little to no resulting plate waste (Interview M9).
- Don Asado, an Uruguayan Cuisine Restaurant, offers single portions, couple portions, family portions and half salads (Don Asado n.d.).

United States:

- Fred’s Market Buffet (Florida) offered a $2 discount on meals if customers cleaned their plate; this reduced plate waste by 80 percent (Sullivan 2013).
- Colleges and universities that have implemented trayless dining and seen a reduction in FLW at various levels (exact metrics not available) include the University of Massachusetts Amherst dining halls, Skidmore College, and Iowa State University (LeanPath n.d.b, in ReFED 2016; Foderaro 2009; Levin 2012).
- The Rochester Institute of Technology estimated that the school saved 10 percent on food procurement costs when it introduced trayless dining (Foderaro 2009).

3.4.2 Approach 2: Increasing Marketability of Produce

3.4.2.1 Description

Retailers in Canada and the United States, especially those that are part of larger franchises, have strict cosmetic standards for produce (e.g., specifications for color, size and shape), stricter than the standards set by federal regulating agencies, due to a perception that customers will not buy produce that is not perfect. Cosmetic standards also apply to other product types (e.g., seafood); however, there are more markets for lower-grade non-produce goods than there are for lower-grade produce (Interview C39). Cosmetic standards are also set by food processors, either due to the standards that their retail customers specify, or to accommodate tolerances of process machinery.

Cosmetic standards increase the amount of culled produce throughout the early stages of the food supply chain. To decrease the amount of culled produce from going to waste, retailers can market and sell second-grade produce at a discounted price in their stores. There are numerous benefits to this approach, across the food supply chain, including the following:

- **Food Production Post-Harvest:** Increasing the range of produce that farmers can sell can reduce the amount of crop left on the field, culled or discarded, and can lower the cost of disposal of off-grade produce.
- **Distribution**: Finding more opportunities for markets that accept off-grade produce, such as frozen produce, would reduce culling.
- **Retailer**: Having a market for second-grade produce reduces shrink (unsold products) and creates positive corporate social responsibility.
- **Consumer**: The consumer can buy quality second-grade produce at a discount while gaining awareness that produce comes in different shapes and sizes.

3.4.2.2 Trends

For years, it has been a common practice for second-grade produce to be sold by farmers directly to customers or to smaller, independent grocery stores (Interview C7). A movement to bring second-grade produce to large, franchise supermarkets in Canada and the United States began with advocacy by NGOs, distributors and farmers and has been gaining momentum. Now, an increasing number of supermarkets are creating their own second-grade produce campaigns. These campaigns typically come with a catchy slogan (further described in the Example Initiatives section) and heavy advertisement, both in stores and in the media, to attract customers to the second-grade produce. Some supermarkets are piloting programs at a small number of stores to test the concept for its viability at a scaled-up level (Interview C9).

In addition to the second-grade fruits and vegetables, farmers have been working on packing and marketing parts of the plants that are edible but typically culled, including leaves, stems, stalks, and second cuttings of regrowth (from tender leaf growth) (Interview U5).

Specific trends in each country are highlighted below.

Canada: Retail stores have been testing second-grade produce lines in British Columbia, Alberta, Saskatchewan, Ontario, and Quebec (Perrault 2016). So far, farmers have noted increase in sales of produce that would otherwise be culled (Interviews C7, C9). However, the separate marketing of second-grade fruit by retailers is still in the nascent stage; most of the chains that have conducted pilot projects selling second-grade produce have not scaled up operations to a large number of stores and/or are still limited to just a few products in the second-grade produce category (Interview C9).

Mexico: In central supply markets, second-grade fruits and vegetables are usually sold under the category of second-grade food. Applicability of cosmetic standards in Mexico is limited to larger supermarket franchises, which only make up about 5 percent of the retail sector (INEGI 2014b).

United States: Campaigns for second-grade produce have been piloted or established in several states, with California as the leader thanks to its large agricultural industry and influence on the market. The most established second-grade produce programs, ones that have gone beyond pilot stage, are currently run by NGOs that are rescuing second-grade produce for affordable distribution or for meal programs, although some are also acting as distributors to larger supermarkets. Farmers and distributors have also created campaigns for second-grade produce (Interviews C9, U5), to help market more of it to retailers.

3.4.2.3 Challenges and Special Considerations

Shelf space is a premium for retailers, as they operate with low profit margins and prefer to stock products that offer higher profit margins (Interviews C9, C41, U39). Since second-grade produce is typically sold at a discounted price, the potential for lower profit margins acts as a disincentive to provide shelf space for imperfect products. Furthermore, discount prices for second-grade produce could exacerbate the consumer perception that this produce is inferior to “perfect” produce, and may contribute to FLW in the long-term by supporting the cosmetic dichotomy (Interview U4).

For farmers, the cost of harvesting and packing produce is the main challenge to marketing second-grade produce, since its lower market value does not go as far to mitigate fixed costs such as storage and staff time (Interviews C7, C41, U5). There is also a concern that by increasing the supply of products to the market, the market prices for all grades of produce may decrease and result in less income for farmers (Interview U3).

Lastly, this approach fails to address the deeper-rooted problem of food-grading specifications' being too stringent (Interview C9). Stringent quality specifications affect all farms that sell to retailers that have high standards for produce (Gustavsson et al. 2011; Stuart 2009). In Mexico, as in Canada and the US, producers selling directly to supermarket chains face the challenge of meeting the established quality and cosmetic standards of those chains (Gomez and Schventesius 2006).

For farmers and distributors to really benefit from increased produce marketability, the best solution is for food-grading specifications to be relaxed so that currently off-grade produce is accepted (e.g., making it acceptable for Grade A cucumbers to be slightly curved) (Interview C9). That way, farmers can benefit from the full market value for more of their harvest and cull less product overall, rather than take a discounted price due to minor cosmetic imperfections.

Specific challenges and considerations in each country are highlighted below.

Canada: Before August 2016, a major challenge to selling second-grade fruits and vegetables in Quebec was the Regulation respecting Fresh Fruits and Vegetables, under the Food Products Act (P-29, r. 3)—which essentially banned the sale of second-grade produce. This regulation was revoked on 4 August 2016 (Government of Quebec 2016; Lunau 2016). Although such strict regulations do not exist in other parts of the country, it is common for retailers to have even stricter cosmetic standards than regulatory bodies and it is anticipated that these high thresholds will likely remain unless the retail industry collectively agrees to make these changes (Interviews C7, C8, C9, C27).

Mexico: Producers selling directly to supermarket chains face the challenge of meeting the established quality and cosmetic standards of these chains. Only those producers with a packing house and marketing department are in a position to develop direct sales relationships with supermarket chains. However, because the chains only accept top-quality produce, producers have created supply-center warehouses to sell leftovers that do not meet the stringent requirements imposed (Gómez and Schventesius 2006).

Mexican produce destined for export must meet the quality standards of the destination market, and available stock is vulnerable to price fluctuations in the importing region; each of these conditions can lead to significant food losses. As stated in Section 2.3.1.1, quality standards (e.g., specific color, size and shape) are established by national-level government agencies, but the retail, distribution and processing sectors set more-stringent cosmetic standards (Buzby et al. 2014; Gooch et al. 2014). A significant portion of Mexico's agricultural exports is destined for Canadian and American markets. For example, of the US$26.6 billion in agricultural exports from Mexico, US$22.9 billion were sales to the United States (Thompson 2016). Since Mexico is a major exporter of fruits and vegetables to markets in Canada and the United States, producers and distributors in Mexico are subject to the stringent cosmetic standards set by the retail, distribution and processing sectors in those countries, leading to the rejection of produce that fails to meet those standards.

United States: One challenge arising from this second approach, in the United States, is marketing competition. Since most of the campaigns for second-grade produce come with catchy names, hashtags, or taglines, companies have started to trademark phrases. This has led to legal issues among well-meaning ICI stakeholders who promote second-grade produce (Interview U5). There is generally a lack of coordination and collaboration among farmers, distributors, and retailers, when it comes to the second-grade produce movement, which can undermine or counteract efforts made by the ICI sector. There is a need for ICI stakeholders to work together, for the approach of increasing marketability of second-grade produce to be successful.

A summary of key considerations for implementing this approach is presented in TABLE 15.

TABLE 15. Key Considerations for Implementing Approach 2: Increasing Marketability of Produce

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium**	For farmers, labor is needed for sorting and packing products that have a lower price point. There are also costs at the retail level, including stocking and the variable cost of floor space used.
Savings (financial savings as a result)	**Medium**	At the retail level, there could be some savings in disposal fees for culled produce that would otherwise go to waste, depending on the uptake of second-grade produce from consumers. For farmers, by selling more produce, more costs for planting, harvesting and packing can be recuperated.
Time to implement (length of time needed to operationalize change)	**Medium**	For retailers, some time is needed to adjust operational systems and grade levels. For farmers, markets need to be developed for additional products.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There will likely be high buy-in from farmers and packers, given higher produce sales, but they may be cautious about supplying second-grade produce if it may negatively affect market prices. Grocery stores will have more throughput and potentially more profit; however, this approach has been slow to scale up.

3.4.2.4 Example Initiatives

Canada:

- No Name Naturally Imperfect™ (Loblaw Companies Limited, in Ontario and Quebec) and Odd-looking Fruit and Vegetables (*Les fruits et légumes drôles*) (Sobeys, in Quebec) are examples of retailer-led campaigns for second-grade produce sold at a discount (Perrault 2016).
- The Misfits (RedHat Co-operative, Alberta) is a campaign led by a farmer co-operative, for second-grade produce; it sells to wholesalers and retailers at a discounted price. This initiative is discussed further in Case Study 3.
- Rebel Food (Discovery Organics, British Columbia) is a produce line developed by a distributor to sell discounted second-grade organic produce to retailers (Discovery Organics 2016).
- Second Life (Quebec) is a company that offers online ordering of second-grade produce baskets for customers to pick up at various locations (Perrault 2016).

Mexico:

- Generally, there is higher acceptability of second-grade produce in Mexico. Central supply markets frequently sell second-grade fruits and vegetables for a lower price than other stock (Interviews M58, M67).

United States:

- I'm Perfect (Walmart, Florida) is a pilot program to sell weather-dented apples at a discount, at 300 stores (Godoy 2016).
- The Misfits (Robinson Fresh, various states) is a campaign for second-grade produce licensed from Canada (see Case Study 3), and is being piloted by various retailers that buy produce from Robinson Fresh—including Associated Foods, in Utah.
- Baldor (New York) sells produce "seconds" at a highly reduced rate in their employee store (Hirsh 2016).
- Unusual but Usable (Fresh Point, national) is a distributor line of second-grade produce which is being marketed for soups, stews, and sauces.
- ImperfectVeg (Church Brothers, California) is a line of produce that that does not meet ICI cosmetic standards and is packed at the farm; the produce includes romaine leaves, cauliflower and broccoli byproduct, and second crops of kale, chard, and spinach.
- Produce with Personality (Giant Eagle, Pennsylvania) is an example of a retailer-led campaign for second-grade produce sold at a discount.
- Imperfect Produce (California) is an online ordering and delivery service for boxes of second-grade produce which also distributes to retail stores—including Raleys and Whole Foods, where the product is sold at a discounted price.

3.4.3 Approach 3: Standardizing Date Labels

3.4.3.1 Description

Producers and retailers use several different terms to inform consumers about the shelf life of food. These various designations include "sell by," "use by," "best before" and "expiration date." There is also a significant variation in the wording of date labels on imported products, adding further inconsistency. Date labels, with the exception of expiration dates, do not indicate the safety of food, and are only meant to convey "peak freshness" or the quality of the product (Natural Resources Defense Council 2013).

The opportunity for collaboration between federal agencies and ICI stakeholders (primarily food manufacturers and retailers) is key to establishing clear and consistent labeling guidelines for best-before dates. Actions that can be taken include the following:

- Returning to "closed" date labeling practices (using symbols or numerical codes to handle stock rotation) or making "sell by" dates invisible to customers but visible/only recognizable to ICI stakeholders (i.e., a business-to-business communication) (NRDC 2013, Smith 2016).
- Removing date labels (through legislation or voluntary ICI stakeholder action) on non-perishable foods such as canned goods (NRDC 2013).
- Providing guidelines that standardize wording and formatting of date labels (Canadian Food Inspection Agency 2015b; USDA FSIS 2016; USDA FAS 2010).

3.4.3.2 Trends

Food manufacturers apply a number of different approaches to determine use-by and best-before labels, which are primarily based on food safety and freshness. These approaches include direct measurement through microbial challenge studies (testing food exposed to typical transport, storage, handling, retail, and home use, for bacteria and pathogens, in order to determine shelf life) and mathematical models based on microbial challenge studies for similar types of food (Nwadike 2016). In the past, the ICI sector standard was "closed" dating, where any information regarding product freshness was only accessible to distributors and retailers, not consumers. Due to consumer interest in the freshness of their food, industry began to move to "open" dating, which communicates a "best before" date that includes a month, day and year. While this shift in labeling increased consumer awareness about the freshness of food, it has also led to FLW from confusion about the meaning of date labels. To address this problem, academic research, government commitment, and reports investigating the issue of date labeling have increased in North America. Most of the attention has been on educating consumers on interpreting date labels. In the United States, where there is no standardization for date labels, there has also been a push for improving regulation.

Specific trends in each country are highlighted below.

Canada: Health Canada and the Canadian Food Inspection Agency (CFIA) share the responsibility for date-labeling requirements in Canada. Health Canada establishes rules related to expiry dates, which are health- and safety-related. CFIA is responsible for the durable-life (best-before) dates, which are an indication of quality, freshness, and other factors, but are not about the safety of the product (Canadian Food Inspection Agency 2014). Products with a shelf life of less than 90 days are required to have a label indicating best-before date. CFIA's date labeling rules include requirements on how the best-before date should look, in both English and French (Canadian Food Inspection Agency 2015).

In Canada, there are only five types of food products that must be labeled with an expiration date: 1) baby formula and human milk substitutes; 2) nutritional supplements; 3) meal replacements; 4) pharmacist-sold foods for very-low-energy diets; 5) formulated liquid diets (Canadian Food Inspection Agency 2014).

Mexico: Date labels are regulated through a compulsory standard, NOM-051-SCFI/SSA1-2010 (general labeling and health and safety specifications for pre-packaged food and non-alcoholic beverages) (DOF 2010). This standard states that either the expiration date or the best-before date must be included in the labels of the products. Expiration dates define the length of time that safety and quality features are maintained if the product is stored according to suggested conditions. Best-before dates define the length of time that quality features are maintained. Products past expiration dates should not be consumed, because of health and safety concerns, whereas products past best-before dates can be consumed.

United States: Currently, the authority to ensure food safety and protect consumers from misleading food package information is delegated to the Food and Drug Administration (FDA) and the US Department of Agriculture (USDA). Both agencies maintain the prerogative to regulate labeling of food products under their respective jurisdictions—meat, poultry, and certain egg products under the USDA, and all other foods under the FDA (NRDC 2013). There is currently no mandatory standard across different types of labels, with the exception of infant formula; however, there is growing interest in this issue. For example, Congresswomen Chellie Pingree proposed the "Food Date Labeling Act of 2016," which would standardize the wording of date labels (Pingree 2016) (see Case Study 4). A voluntary standard was developed through a working group (on date-label standardization) that includes the Grocery Manufacturers Association (GMA) and the Food Marketing Institute (FMI). This standard reduces the 10 different date labels currently in use to two standards, "Best if used by" and "Use by," the former being a description of the quality of the food, and the latter used when food safety considerations are a factor (Manuell 2017). This voluntary standard is anticipated to have widespread adoption by mid-2018.

3.4.3.3 Challenges and Special Considerations

Some ICI players remain skeptical of date-label standardization as an approach that can significantly reduce FLW. Extended dates may mean that consumers keep some products in their cupboards or refrigerators for longer. However, if consumers continue to over-purchase products that they do not need, then changing labels only pushes out the timeline before they ultimately dispose of products in their home (Interviews C41, U39). At the retail level, there are also limits on the potential effectiveness of date-label standardization. Grocery stores tend to have high product turnover and already arrange older products closer to the front of their shelves so they sell first. However, it is still common practice to remove products that are coming close to the best-before date (Interviews C41, U39). Furthermore, even with standardized date labels, retailers may not stop the practice of over-ordering products in order to get the volume discounts applied to order minimums set by wholesalers, and will still discard older products (that may not be close to their best-before date) to make room for newer stock.

Another challenge to standardizing date labels is how messages related to food safety are portrayed in the media. Contradictory messages have been promoted in media, leading to increased confusion for stakeholders. For example, one article states that mold can be scraped off yogurt so it can be eaten months past its expiry date without a problem (Boesveld 2013), while another states that moldy yogurt should be discarded because some molds produce poisonous substances that can cause illness (Touzalin 2016). Concerns regarding food safety will always drive government, manufacturers and retailers to be cautious in how they label food and educate consumers.

Specific challenges and considerations in each country are highlighted below.

Canada: The Consumer Packaging and Labeling Standards dictate how dates are declared on a product (CFIA 2014), but do not guide how food manufacturers need to calculate best-before and expiry dates (with the exception of some specific foods that can harbor bacteria, when packaged in ready-to-eat formats) (MacRae et al. 2016). This means that there is still inconsistency in the methods used by companies to determine these dates. Although only products with less than a 90-day shelf life require labeling, many companies still put date labels on their products, as there is no regulation that prevents them from adding date labels.

While food labeling is part of the mandate of the CFIA and Health Canada, reducing FLW as a result of labeling is not a mandate (Interview C33). The CFIA recommends consumers use a cautious approach in determining if food is safe to eat, to ensure that public health is protected. For example, the CFIA website states, "Never use your nose, eyes or taste buds to judge the safety of food. You cannot tell if a food may cause foodborne illness by its look, smell or taste. And remember: If in doubt, throw it out!" (Canadian Food Inspection Agency 2014).

Mexico: There are some challenges to applying date labels to imported products, as they need to follow the same format as the NOM-051-SCFI/SSA1-2010 standard. Guidelines on how to implement the labeling standard for beverages and food were released in 1996 (when the standard was published) and revised in 2012 (Herrera 2012). Nevertheless, importers, especially smaller ICI stakeholders, may not have the resources to interpret and translate labels from the imported goods to the standard format (Interview M67).

According to the NOM-051-SCFI/SSA1-2010 standard, importers are responsible for labeling imported foods. For pre-packaged imported products, the name, denomination or person and fiscal address of the company responsible for the product must be indicated on the label. This information must be incorporated in Spanish onto the prepackaged product label once inside Mexico (after customs clearance and before the product is marketed) (DOF 2010). This presents a challenge to small importers, who may lack the resources to re-label the products in accordance with this mandatory standard (Interview M67). Supermarket chains, particularly those that verify and require labeling, may reject imported products that have not been adequately re-labeled. As a result, importers who do not comply with the labeling requirements may have trouble commercializing their products, leading to food waste.

United States: A unique challenge in the United States is the varying laws on date labels from state to state. For example, the State of New York does not require date labels to be applied to any products, while six of its neighboring states (New Jersey, Pennsylvania, Connecticut, Massachusetts, Vermont, and Rhode Island) do have labeling requirements (NRDC 2013). In addition, while 20 states plus the District of Columbia have regulations addressing sale of past-dated food products, 30 states have no such restrictions. This disparity between states poses a significant challenge to harmonization of date labels and makes nation-wide initiatives to educate and inform consumers highly challenging. The inconsistency between states also makes it more challenging to discern what scientific evidence should be considered related to food safety (Leib et al. 2016, 30). Because state laws differ so much, only federal legislation would provide a uniform system that does not change as consumers cross state boundaries.

A summary of key considerations for standardizing or clarifying date labels is presented in TABLE 16.

TABLE 16. Key Considerations for Implementing Approach 3: Standardizing Date Labels

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium**	For food manufacturers and retailers, various costs can be incurred by changing date labels, using another type of tracking system or translating labels that cannot be read by consumers, adding to capital costs.
Savings (financial savings as a result)	**Medium**	For retailers and manufacturers, there could be some cost savings from not having to discard products that are close to or past their date labels. However, if consumers are keeping products longer at home and do not buy as much, these savings may be offset by decreased revenues.
Time to implement (length of time needed to operationalize change)	**Medium**	Research and legislative changes are needed to make adjustments.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There is a need to drive voluntary change in the food industry, and/or for government to legislate change, as well as support programs for consumer education.

3.4.3.4 Example Initiatives

Canada:

- The CFIA has provided clear guidelines on best-before and expiry dates in the Consumer Packaging and Labeling Regulations. These are now used by various organizations, which have improved consistency.
- Food Banks Canada provides guidance on how to interpret date labels for food banks (Food Banks Canada 2013).
- Food banks are using food past its best-before date and providing their customers with clear guidelines about food safety, including directing them to Health Canada. For canned goods, they accept and distribute food that is up to two years past its best-before date (Food Banks Canada 2013).

Mexico:

- *Grupo Empresarial Ángeles* published an article about different food and beverage labels to give guidance and mitigate consumer confusion on the meaning of labels (Hospitales Ángeles n.d.).

- Greenpeace published information in its website about how to read labels of food and beverages in Mexico, providing guidance to consumers about expiration and best-before dates (Greenpeace Mexico 2016).
- Guidelines on how to implement the labeling standard for beverages and food were released in 1996 (when the standard was published) and revised in 2012 (Herrera 2012).
- The Consumer Goods Forum (CGF), a network of 400 of the largest consumer goods companies in 70 countries (including Mexico), together with Champions 12.3, issued a call to standardize date labels around the world by 2020. In an effort to reduce food waste and save money, the proposed labeling standards would consist of just two simple options: "Use by" and "Best if used by" (Pilotzi 2017).

United States:

- A voluntary standard was developed by a multi-stakeholder group, led by the GMA and FMI, that standardizes date labels by using one of two options: "Best if used by" or "Use by" (Manuell 2017).
- Walmart has shifted its own-brand products to "best used by" labels, in an effort to standardize date labeling (Kowitt 2016).
- Congresswoman Chellie Pingree initiated the development of two pieces of legislation that have been introduced to Congress; the "Food Recovery Act," and the "Food Date Labeling Act." This initiative is further discussed in Case Study 4.
- Some manufacturers, such as Cargill, have added "freeze by" and "use by" on their packages to help inform consumers about food safety (Cargill 2016).

3.4.4 Approach 4: Packaging Adjustments

3.4.4.1 Description

Incorrect and ineffective packaging is a major contributor of FLW in the distribution and retail stages of the supply chain (Uzea, Gooch and Sparling 2014). In a food system of long-distance supply chain, and global food products, packaging can also play an important role in reducing food spoilage. New packaging technologies and approaches can offer solutions that can contribute to creating more-sustainable packaging while improving food safety and durability.

Packaging helps contain and protect food as it is transported, stored and moved through the supply chain (Verghese et al. 2013). In addition to protecting food during transportation and storage, food packaging can control portion size, helping consumers to manage waste in the home.

3.4.4.2 Trends

There have been some technological advancements that both improve the packaging and reduce food spoilage. These include the following (Agriculture and Agri-Food Canada 2015b, 6):

- **Rapid detection:** Digital temperature monitoring labels can provide data on temperature fluctuations of perishable products during distribution and storage, to avoid spoilage. Microchips in labels can also indicate when food has spoiled. For a few more cents per package, small sensors are available that can monitor temperature or enzyme levels and information from the sensors can be sent to a smartphone (Lingle 2016).
- **Quality preservation:** Ethylene strips use a mixture of high-tech minerals and clay to absorb ethylene gas, delaying ripening of produce, keeping it fresher for longer periods of time.
- **Interactive sensors:** Electronic food labels can be used to lower the price of a product as it nears its sell-by or best-before date.

- **Nanotechnology**: Nanomaterials (smaller than 10^{-9} m in size) can be used to keep food fresh. Nanocapsules can be used to remove chemicals or pathogens from food, and nanoemulsions can be used for better availability and dispersion of nutrients. Biodegradable nanosensors can be used for monitoring temperature, moisture and time. Nanoclays and nanofilms can also be used as barrier materials to prevent spoilage and prevent oxygen absorption (Bradley et al. 2011).

There are also non-technologically-based packaging approaches to help reduce FLW. Portioning and planning meals have both been identified as examples of behaviors that can reduce FLW (Stuart 2009), and food packaging that assists customers with portion control has been identified as a solution. This has led to the creation of packaging that is tailored to consumers' eating patterns or the size of household unit (e.g., "portion sizing" for single households). Retailers are experimenting with resealable pouches, half-dozen containers of eggs, half loaves of bread and smaller beverage cans. For example, having smaller-sized packs or individually wrapped items (e.g., chicken breasts) within larger packs allows for easy freezing and defrosting (Interview U39). Other packaging approaches include separating packaging; for example, a spinach bag with a central seal so that consumers can open half of the package at a time.

Specific trends in each country are highlighted below.

Canada: The Packaging Association of Canada (PAC) recently formed an FLW working group dedicated to identifying packaging solutions that reduce FLW and educating stakeholders to encourage uptake. Founding members include Sobeys, Loblaw, Target, Molson Coors, Nestle, DuPont, Dow Chemical and Sealed Air. The PAC working group is developing best-practice case studies to support ICI stakeholders (PAC Food Waste 2014).

Mexico: Some multi-national franchise supermarkets are beginning to address FLW through adjusting packaging, but this is in the initial stages of development. For example, the use of nets and packaging for fresh fruits instead of selling them by bulk without packaging occurs in supermarkets such as Walmart and Sam's Club (Interview M58).

United States: A US report on consumer attitudes found that the most popular changes respondents would like to see were a greater number of resealable packages (57%) and more variety in product sizes (50%) (Neff et al. 2015). Respondents indicated preferences for baked goods, bagged salad, bread, and meat to be offered in alternative portions (43, 41, 39 and 29%, respectively).

3.4.4.3 Challenges and Special Considerations

While packaging can play an important role in reducing FLW by extending shelf life and maintaining quality, there are other environmental considerations, such as the burden of packaging waste in landfills. Most packaging is made of plastic, which often takes hundreds of years to decompose. In the case of bioplastics, only some types are compostable, which creates confusion both for consumers and for waste processors. Furthermore, it takes resources and energy to manufacture the packaging. A life-cycle assessment may be useful to help decide when the use of packaging is better than leaving the food product without packaging (Heller and Keolian 2003). Trade-offs will vary significantly across different product categories and can send extremely confusing messages to even the most environmentally minded consumer (Morier 2016).

While the field of nanotechnology as applied to food preservation is growing, there are concerns at the consumer level with regard to the impact and implications of nanofoods, and the application of nanomaterials in food processing (Shoffstall and Gille 2015). There is also the concern that using nanotechnology to extend shelf life in stores does not address the issue of consumers' possibly still purchasing too much food and not consuming it before it spoils.

Specific challenges and considerations in each country are highlighted below.

Canada: One of the main challenges to improving packaging is that the cost of these adjustments has to be justified. These technologies are in nascent stages and there has not been a clear business case presented to industry. Clay nanotechnologies have been shown to be effective, but there have not been longer-term risk and impact studies conducted yet. As well, manufacturers and packaging associations have concerns regarding regulations around nanotechnology, and the potential for material to leach into food. This leads to another concern with consumer perception: manufacturers and packaging associations worry that consumers will be afraid of the new technology (Interviews U38, C28).

Mexico: It is still common to buy perishable food from bulk bins, rather than in packages. In this context, there is likely to be less customer desire to buy packaged food, especially since packaged foods tend to cost more (Interview M59). It is still not a common practice to use smart packaging (Interview M59). Food-purchasing patterns may change over time if more people demand (and can afford) gourmet markets and grocery stores where packaged food and imported products are sold.

United States: Packaged foods are already very prevalent in the United States and account for a large percentage of waste. Food and packaging containers combined account for an estimated 45% of materials landfilled in the United States (US EPA 2016c). Adding more packaging, without ensuring that the packaging can be re-used or recycled, would likely increase this amount of waste, which may counter the associated reduction of FLW.

A summary of key considerations for implementing the approach of adjusting packaging is presented in TABLE 17.

TABLE 17. Key Considerations for Implementing Approach 4: Packaging Adjustments

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium**	Manufacturers, distributors and packers will incur capital and operational costs to change packaging approaches, which costs may vary, depending on the packaging technology and produce.
Savings (financial savings as a result)	**Medium**	Packers, manufacturers, distributors and retailers could benefit from some savings by avoiding disposal fees for spoiled food; and by reduced labor for culling or restocking shelves, if products have a longer shelf life. Some additional profit could be yielded from increased sales as a result of extending shelf life and/or meeting consumer needs. However, in Mexico, the savings are anticipated to be lower because consumers tend to prefer bulk presentation of perishables rather than packaged presentation in store.
Time to implement (length of time needed to operationalize change)	**Medium**	Some technologies still need more refinement and testing before they can be brought to market. For existing technologies, products may need to be redesigned and tested on customers to obtain feedback on their effectiveness.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	Coordination is needed among packers, manufacturers, distributors and retailers for packaging changes to happen within the food industry, but this is already a common practice for existing products. Stakeholder support is anticipated to be lower in Mexico, as it depends on customers coming to accept packaged products and on their willingness or ability to pay more.

3.4.4.4 Example Initiatives

Canada:

- Sealed Air conducted research on consumer perceptions about packaging, using an unpackaged cucumber versus a packaged cucumber. While consumers preferred the unpackaged cucumber, once they were informed that the packaged cucumber would have increased shelf life to two weeks, the consumer preference changed (Cotterman 2015).
- In 2011, Innovative Food Systems Corporation received federal government funding to research antimicrobial packaging technology to keep fruits and vegetables fresher, from the time they are picked to when they are consumed (Agriculture and Agri-Food Canada 2011).

Mexico:

- Walmart has designed containers for suppliers to use during transportation of fresh food, to prevent damage. Some containers are made of a flexible fabric instead of rigid plastic, so that they are able to adjust and flex during truck movement, which reduces breakage (Interview M58).
- Some supermarkets are offering individual products packed in resealable bags to provide a sealed storage option between uses. These bags contain common snacks such as sliced carrots, jicama and other vegetables.

United States:

- Wegmans Food Markets, Inc., a supermarket chain in New York, started sealing single-serving meat portions, increasing shelf life of in-store meat, shrinking their "Club Pack" down to a "Family Pack," and using blemished produce for ready-cut fruits and veggies. This initiative is further discussed in Case Study 5.
- Bemis Co. developed a novel packaging technique, utilizing Du Pont materials, that separately seals two compartments and allows the consumer to peel and reseal each compartment at least 20 times with fingertip pressure (Du Pont 2015).

3.4.5 Approach 5: Improving Cold-Chain Management

3.4.5.1 Description

Cold-chain management refers to the systems and infrastructure that maintain appropriate temperatures for different food types. Cold-chain management is key to reducing loss of produce and other perishable foods during storage and distribution to retail and foodservice stakeholders (ReFED 2016).

Cold-chain management is divided into five stages: pre-cooling (cooling products to a suitable transportation temperature), cold storing before transportation, cold transportation, cold storage chambers (at points of sales), and refrigeration equipment sales (Medina 2009, 23). Investment in all cold-chain infrastructure stages and corresponding processes has significant potential to reduce FLW.

Cold-chain infrastructure is limited in Mexico whereas it is well-developed in Canada and the United States. Therefore, this section is focused on improving cold-chain management in Mexico. However, opportunities to improve cold-chain management in Canada and the United States may also exist, such as replacing aging cooling equipment.

3.4.5.2 Trends

In Mexico, multiple governmental organizations, such as The Mexican Transport Institute (*Instituto Mexicano del Transporte*—IMT) and the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*—Sagarpa) identified the need for greater access to cold-chain infrastructure across the country. For example, in the meat sector, existing infrastructure only meets 60% of demand for cold-chain management (SIPSE 2016). Spoilage and contamination rates in this sector are high and continue to increase.

In response to these needs, IMT and Sagarpa adopted cold-chain management as a strategy to reduce FLW after conducting studies on this topic. Elements of this strategy include technical assistance and financing programs to give support to farmers and distributors for improvements in cold-chain management. This support has contributed to a fourfold increase in cold-chain management in Mexico over the past ten years (Morales 2016, 47). However, most of new cold-chain infrastructure is used to facilitate the export of produce to the United States and Canada rather than to distribute to domestic markets. Government action to support farmers and distributors is further discussed in Section 3.5.

3.4.5.3 Challenges and Special Considerations

Access to capital is a significant challenge to investing in cold-chain infrastructure. Individuals who run small distribution companies own more than 50% of the trucks used for food transportation in Mexico (Morales 2016, 47). These smaller distributors may not have the independent financial capacity to invest in expanding vehicle fleets and updating transportation and refrigeration technology to more efficient models that are better for cold-chain management. They may not have adequate funds for ongoing operations (e.g., to pay for electricity) and maintenance of cold-chain infrastructure. For these reasons, only about 50% of perishable food products are refrigerated during transport in Mexico (Wageningen UR and Sagarpa 2014).

Most cold-chain infrastructure in Mexico is used for export markets (SIPSE 2016). In addition to opening new export markets, export-driven cold-chain implementation can significantly affect the profitability of operators in the post-harvest and distribution sectors. Such operators would have high upfront investment costs paired with increased operating risk resulting from volatility in export-market commodity prices (Wageningen UR and Sagarpa 2014).

A summary of key considerations for implementing improvements in cold-chain management is presented in TABLE 18.

TABLE 18. Key Considerations for Implementing Approach 5: Improving Cold-Chain Management

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**High**	Technology for cold-chain infrastructure and transportation is not accessible to most distributors because they are small ICI stakeholders or individual owners, without access to sufficient capital. In addition to acquisition barriers, advanced cooling technologies typically require more electricity, increasing operational costs for distributors.
Savings (financial savings as a result)	**Low**	Due to the high cost of electricity for ongoing operation of cooling chambers, minimal savings are anticipated for distributors, despite the savings in avoided FLW.
Time to implement (length of time needed to operationalize change)	**Medium**	Improvements in cold-chain management are predominantly occurring among large ICI stakeholders, as they have more capital resources to acquire infrastructure. For individual truck owners and wholesalers, the implementation time is expected to be longer, due to the time and effort required to procure refrigerated units.

Key Consideration	Rating	Explanation of Rating
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There is a general desire to improve cold-chain management and infrastructure, but the lack of individual economic resources available to the majority of stakeholders (individual truck owners) reduces the likelihood of buy-in.

3.4.5.4 Example Initiatives

- *Frialsa Frigoríficos* opened the biggest distribution center with cold-chain management in Mexico, in Tepeji del Río, Hidalgo. This facility also acts as one of the main distribution centers in Latin America. *Frialsa Frigoríficos* has a network of 15 distribution centers with Inspection Type Certification (TIF), located strategically in states with higher food production or consumption rates. These distribution centers have the capacity to store products such as fish, seafood, vegetables, fruit and prepared products (e.g., cakes and ice cream) (Inbound Logistics Latam 2016).
- CMR created standards that include storage at proper temperatures, inspections for defrosting, and keeping cold chambers at 5ºC and frozen chambers at -18ºC, to mitigate issues of substandard product quality due to problems in cold-chain management (CMR 2014, 12–13).
- The Mexican Transport Institute (*Instituto Mexicano del Transporte*—IMT) built a database that identifies areas that lack or have a shortage of cold-chain management. This initiative is discussed further in Case Study 6.
- The IMT also conducted a study to evaluate two modes of packing fresh pineapples for export, which found that cold storage directly after harvest prolonged the storage time by one month. This initiative is discussed further in Case Study 7.

3.4.6 Approach 6: Value-added Processing

3.4.6.1 Description

Industrial food processing can help reduce FLW by extending shelf life (Spooner 2016) and making use of food byproducts that are typically wasted. Increasing shelf life also keeps food from spoiling along the food supply chain, and is therefore beneficial to all stages. Culled and surplus fresh foods, such as produce, meats and seafood are directed to food processing when possible (Interviews C7, C12, C39). Although the market value of culled products is lower, food producers sometimes benefit by selling (or transferring) what they can to food processors as a cost-recuperation mechanism to avoid disposal costs (Interview C12). Beneficial uses of food byproducts in value-added processing is a potential additional revenue stream for food processors, through creating new products, and in addition eliminates the cost of disposal of byproducts, were they to be sent to waste.

This approach also benefits food rescue organizations, as they typically have limited cold storage space and cold-chain transport and therefore cannot move perishable donations fast enough before they spoil (Interview C37). Processing of donations (either before they are transferred to the organization or by a partner) gives the food rescue organizations more time to distribute the donations and alleviates some of the pressure for cold storage and cold-chain transport (ReFED 2016).

3.4.6.2 Trends

Common methods for food processing include chemical processes (adjusting water content, addition of chemicals, pH control) and physical processes (sterilization, pasteurization, blanching, frying, freezing, irradiation) (Ontario Ministry of Agriculture, Food and Rural Affairs 2016).

The use of culled products for food processing is already a regular practice in the food supply chain (Interview U38). For meat and seafood, due to their higher value, the trim is used for stocks, burgers, meat/seafood pieces, and other processed meat/seafood products (Interviews C12, C39). For fruits and vegetables, culled items can be processed via juicing, canning or pureeing (Interviews C7, C35). Another form of processing for fruits and vegetables is transforming them into a ready-to-eat product, such as baby carrots, maraschino cherries and stir-fry or soup mixes (Interviews C7, C40, U6).

Value-added processing is currently under-utilized in transforming typically inedible food byproducts into edible products (Interview U24), although research in this area is expanding. Another market that is not well-developed is seasonal processing close to farms, to buffer bumper crops (Interview U19).

Specific trends in each country are highlighted below.

Canada: The majority of food processing is concentrated in Ontario (Sparling and Cheney 2014, 21). The areas where facilities are located are close to dense population centers, not farms, although there are some rural food-processing operations closer to farms (Interview C40) and they are increasing in number, particular small artisanal processors. The added benefit to farmers when there is a locally available commercial food processor is that they are able to sell an entire field of crop for food processing, versus needing to sort and cull crops that do not meet the specifications for the fresh market (Interview C40).

Mexico: Processing meat and fish byproducts into fish meal and meat meal is a common value-added processing approach. Meat-meal and fish-meal products are commonly used for animal consumption, which is further described in Section 4.4.6. In addition, higher-quality meat meal and fish meal are used for human consumption, as is further discussed in Section 4.4.1.

United States: The United States Department of Agriculture (USDA) has been conducting research and collaborating with start-up ICI stakeholders to commercialize technologies for repurposing surplus food for processing into products for human consumption (Interview U24). The focus of the research activities has been on plant-based products, such as pomaces and byproducts from beverage manufacturing (Interview U24). This research program is further described in section 3.5.5.

3.4.6.3 Challenges and Special Considerations

Excess farm-raised food appropriate for value-added processing often becomes available from many farms all at once—for example, during times of harvest. In addition to the lack of processing facilities, there is a lack of sufficient storage to hold stock for food processing when there is an overabundant crop. A formal processing model for "contingency" (additional processing capacity meant for seasonal variations), by which potentially wasted food at any time can be processed, is absent (Interview U19).

Another challenge is transportation of raw materials to processors. With increasing rates of urbanization, food processors are generally farther from farms than they used to be. There are fewer opportunities for farms to send their culls to processors, or the cost of transportation becomes too high for the option to be financially viable, given the unavoidable costs of harvesting and the cost of storage, which is expensive (Interview C7).

While not considered a challenge to value-added processing, special consideration should be taken regarding potential health and environmental impacts from processing wasted food into value-added products. Heavily processed foods generally have lower nutritional content, or a higher amount of unwanted nutritional qualities (e.g., fat, salt, sugar) (Roychoudhuri 2008). Processing also generally uses more packaging, energy, and transportation, which has environmental impacts. There is a need to balance the objective of reducing FLW with not increasing the number of unhealthy or wasteful food products on the market.

Lastly, with regard to developing new value-added products, a key challenge is that health or import/export regulations may not be updated to handle such products (or not without a lot of paperwork), both domestically and internationally, which may limit the markets for where the products can be sold (Interview C40).

Specific challenges and considerations in each country are highlighted below.

Canada: In Canada, the amount of food processing has declined since the early 2000s (Sparling and Cheney 2014, 19), especially for fruits and vegetables. Operations have been moving to the United States, where food processing is less expensive (Interviews C7, C40). Existing Canadian food-processing operations have challenges in getting products to market, due to distances as well as to import and export regulations in cases when the United States is an end-market for manufactured food products (Interview C40).

Mexico: In Mexico there is a lack of regulatory procedures to preserve and use wasted food for processing for human consumption. There is also inadequate cold-chain management, including a lack of facilities for cold storage in smaller markets and central supply markets. The lack of regulation and infrastructure can lead to potential food safety concerns.

United States: Although the federal government has invested in research initiatives to develop and commercialize technologies, such as the USDA's Agricultural Research Center, there are still many processing byproducts that have not been thoroughly researched for new uses (Interview U24).

A summary of key considerations for implementing the approach of value-added processing is presented in TABLE 19.

TABLE 19. **Key Considerations for Implementing Approach 6: Value-Added Processing**

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**High**	Capital investment in processing equipment, installation, manufacturing-line optimization, commissioning and labor requires financial resources, which may not be available to entrepreneurs who wish to use more-innovative food processing techniques for wasted food. In some cases, competitive domestic and foreign markets may make these costs challenging to justify in absence of an adequate return on investment.
Savings (financial savings as a result)	**Medium**	The savings can be win-win for both surplus-food generators and food processors. Surplus-food generators save on the cost of managing waste, while food processors or NGOs can acquire large amounts of food for a discount or for free. However, animal feed markets represent a competing interest for low-cost surplus food, which may make value-added processing less attractive.
Time to Implement (length of time needed to operationalize change)	**Medium**	Food processors need time for procurement and set-up of new operations, which can be done in a shorter term, but may need additional time for the ICI stakeholder to scale up to be profitable. Furthermore, time and effort is required to set up more formal procurement processes to make processing of wasted food a norm.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	Support exists where there is a demonstrated financial incentive versus sending to animal feed, recycling, or disposal. Given the ease of disposal alternatives for wasted food, only products with high market value would support this approach. NGOs such as food banks have high interest in this approach because of the potential for large donations of high-quality food products with a longer shelf life. However, most large manufacturers and retailers are cautious about liability and legal risks, but are increasingly interested in environmental and social benefits, as well as tax incentives.

3.4.6.4 Example Initiatives

Canada:

- Canadian Prairie Garden (Manitoba) purchases whole fields of fruits and vegetables, as well as culls, and turns them into nutritionally-dense, preservative-free purees that ship all over North America (Interview C40).
- Tristar Seafood (British Columbia) repurposes crab meat from off-grade crabs and sells it as crab meat pieces (Interview C39).
- BC Tree Fruits (British Columbia) opened a cidery that uses culled fruit for cider-making (Interview C7). This initiative is further discussed in Case Study 8.

Mexico:

- Grupomar (Manzanillo), *La Nueva Viga* Market (Mexico City) and *Productos Piscícolas* (Morelia) collect and process fish waste to produce fish meal (see Case Study 18).

United States:

- Fruitcycle (Washington, DC) is a social enterprise making locally sourced snacks from produce that would otherwise go to waste, and providing jobs for women who have been formerly incarcerated, homeless, or are otherwise disadvantaged (Fruitcycle 2016).
- Whole Vine (California) produces nutritious flour from vineyard waste such as grape seeds and pomace (Whole Vine 2016).
- DC Central Kitchen (Washington, DC) and L.A. Kitchen (California) process culled vegetables, fruits, and other primary ingredients into nutritious food products for social agencies and government contracts (Interview U33).
- Forgotten Harvest (California) and ConAgra Foods partnered to convert the waste trimmings from manufacturing of a ConAgra snack, into whole snacks for distribution to communities in need (Forgotten Harvest 2016) (Interview U38).
- ConAgra Foods (Iowa) developed a generic, blended label for puddings that were mixed during process changeovers between flavors and could not be sold in traditional channels but are suitable for secondary markets (ConAgra 2017; Tavill 2017).
- Campbell Soup Company (New Jersey) and the South Jersey Food Bank partnered to create Just Peachy Salsa as a way to use culled peaches for a shelf-stable product that is sold as a fundraiser for the food bank (Interview U37). This initiative is further discussed in Case Study 9.

3.4.7 Other identified approaches to source reduction of FLW

The last four identified FLW source reduction approaches (Operational Efficiencies and Technology in Manufacturing, Limiting Number of Menu/Product Options, Alternative Purchasing Models, and Optimizing Ingredient Use) could be beneficial in addressing FLW reduction and causes of FLW across the food supply chain, introduced in Section 2.3. However, these approaches were not discussed in detail because they were not frequently mentioned in the literature reviewed and not referenced by surveyed key stakeholders.

3.5 Policy and Education/Awareness Program Opportunities

There are opportunities for policies and education/awareness programs to support various approaches to FLW reduction and help move them forward. This section presents examples of promising policies and programs that have been implemented globally, regionally in North America, or in one of the three countries.

3.5.1 International

There have been multiple global commitments to reduce FLW. The most prominent is Sustainable Development Goal (SDG) 12, which is "ensure sustainable consumption and production patterns" (WRI 2016, 24). Within SDG 12, one of the targets (12.3) states, "by 2030, halve per capita global FLW at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses."

In 2011, the FAO of the United Nations, an intergovernmental organization, and Messe Düsseldorf, a private trade organization, collaborated with donors, bi-and multi-lateral agencies, financial institutions, and private-sector partners to lead Save Food, one of the largest worldwide initiatives to fight FLW (Save Food n.d.). The Save Food initiative launched a campaign in 2013 titled Think.Eat.Save (UNEP 2013). This was a global campaign to reduce FLW, with a target audience of consumers, retailers and the hospitality industry (UNEP 2013). The campaign website provided tips to consumers and retailers on ways to reduce FLW through easy, everyday actions. It also served as a platform for organizations running FLW reduction campaigns to exchange ideas and resources.

A leading FLW reduction program outside of North America is the Waste and Resources Action Programme (WRAP), an organization that began as a government-funded program in the United Kingdom (UK). WRAP has a mandate to investigate and tackle the causes of FLW generation and the solutions. WRAP's combination of policies and projects has successfully reduced FLW in the UK by 21% over five years (WRAP 2015). Frameworks for action include the Courtauld Commitment and the Hospitality and Foodservice Agreement (Parry 2015, 41) (see Case Study 33). Launched in 2005, the Courtauld Commitment is a voluntary agreement undertaken by grocery stores, to reduce FLW (WRAP n.d.a). It was implemented in three phases, with the last phase completed in 2015. Activities in the program included technical assistance for ICI stakeholders to reduce FLW, research on packaging design, and consumer awareness actions, such as the highly publicized Love Food Hate Waste campaign. The Hospitality and Foodservice Agreement is a voluntary agreement undertaken in the hospitality and foodservice sectors, to reduce FLW through supporting ICI stakeholders with resources, such as guides for menu planning, food storage, food preparation, and portioning (WRAP n.d.b). Both programs have now merged into the Courtauld Agreement 2025, which has a target of reducing food and drink waste by 20% by 2025 (WRAP n.d.c).

Another country with a national FLW reduction program is South Korea. It has a voluntary program for FLW reduction—designed for restaurants, hotels, schools, and rest areas on highways—which includes awareness actions such as the cafeteria-based "no-leftover day." The country's Food Waste Reduction Plan includes several programs that encourage diversion of organic waste—including a FLW disposal ban, and collection and processing infrastructure (Innovation Seeds n.d.).

Besides government commitments, industry associations have been setting targets to reduce FLW. For example, the Consumer Goods Forum, the largest multinational industry association, has committed to reduce FLW from member operations by 50 percent by 2025 (Consumer Goods Forum 2016). Another example is the Champions 12.3 coalition, a coalition of executives from governments, businesses, international organizations, research institutions, and civil society dedicated to achieving the UN's Sustainable Development Goal 12.3: "to halve the per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses" by 2030 (United Nations 2016). Quantifying FLW and pursuing strategies to reduce FLW are among the primary objectives of this coalition (Champions 12.3 n.d.)

3.5.2 Regional

At the North American Leaders Summit in June 2016, FLW reduction was included as part of the North American Climate, Clean Energy, and Environment Partnership Action Plan. Specifically, the Action Plan stated that the three governments will "Support the regional commitment and collaboration initiative under the Commission for Environmental Cooperation using voluntary measures to reduce, rescue and recover food waste in North America, in line with Target 12.3 of the UN Sustainable Development Goals, which envisions a 50% reduction in global food waste by 2030" (Government of Canada 2016d).

In addition to the above commitment, Mexico is also a member of the Community of Latin American and Caribbean States (CELAC). CELAC committed to halve FLW by 2030, under its Plan for Food Security, Nutrition and Hunger Eradication 2025 (FAO 2016a).

3.5.3 Canada

3.5.3.1 Government

Environment and Climate Change Canada introduced the Strategy on Short-lived Climate Pollutants (SSLCP) in 2017. The SSLCP is focused on slowing the rate of near-term warming by reducing emissions of short-lived climate pollutants, while also making progress toward national air-quality and health priorities. In response to Canada's commitment to develop and implement a national methane strategy—as indicated in the Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership—the SSCLP includes a commitment to begin "consultations on strategies to reduce avoidable food waste, increase organics diversion, and increase recycling and reuse," (ECCC 2017).

At the regional or provincial level, examples of government-led initiatives in British Columbia, Ontario and Quebec are highlighted below:

- The British Columbia Ministry of Environment developed an FLW reduction toolkit to help municipal-level governments with implementing FLW reduction strategies in their jurisdictions (British Columbia Ministry of the Environment 2016).
- Metro Vancouver Regional District acquired trademark rights from WRAP for the Love Food Hate Waste public awareness and consumer education campaign for reduction of food waste. This campaign was implemented in 2014 (Cech 2015).
- Ontario enacted the Waste-Free Ontario Act, which specifies that reducing FLW fits within the agenda to create a circular economy and reduce climate-change-inducing GHG emissions (Government of Ontario 2016a). The provincial government is also convening an FLW stakeholder group made up of all levels of the ICI sector, to develop a food and organic waste framework. This framework will serve to guide future government policy and action regarding its FLW reduction targets (Government of Ontario 2016b).
- The Quebec Ministry of Agriculture, Fisheries and Food has committed to reduce food waste under their 2015-2020 Sustainable Action Plan (Quebec Ministry of Agriculture, Fisheries and Food 2017). Also in Quebec, *Amies de la Terre de Québec*, in partnership with Recyc-Québec, launched the *Sauve Ta Bouffe* (Save Your Food) Campaign, which aims to reduce FLW through a multifaceted approach (Sauve Ta Bouffe 2017). The main action types include community eat parties, public engagement booths, food-waste reduction workshops, and public conferences.

3.5.3.2 ICI

On the ICI sector side, Provision Coalition, a nongovernmental organization comprising members of Canada's food and beverage industry, is providing FLW reduction strategies or solutions to its members (Provision Coalition 2016). The Coalition has published a report, *Developing an Industry Led Approach to Addressing Food Waste in Canada*, and launched a Food Waste Reduction and Best Practices Toolkit (Provision Coalition 2016). The toolkit provides a framework for food processing and manufacturing stakeholders to assess FLW in their operations, identify root causes of FLW and evaluate solutions that aim to reduce FLW. A number of companies have piloted this toolkit so far.

Another countrywide initiative is the National Food Waste Reduction Strategy, which was proposed by the National Zero Waste Council (NZWC), an organization that includes ICI and government stakeholders (Musulin 2016). This strategy was built on three pillars for change: policy, technological innovation and public engagement. Elements of FLW reduction in the strategy included advocacy for a national FLW reduction target, technology to prolong shelf life of food, clarification of date labels and a consumer education campaign to reduce FLW (NZWC 2016).

3.5.4 Mexico

3.5.4.1 Government

Federal ministries with programs and strategies to support and promote post-harvesting activities in the food supply chain to reduce FLW include the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*—Sagarpa), the Ministry of the Environment and Natural Resources (*Secretaría del Medio Ambiente y Recursos Naturales*—Semarnat) and the Ministry of Social Development (*Secretaría de Desarrollo Social*—Sedesol).

Sagarpa's primary focus is to reduce FLW in food production systems across Mexico. Sagarpa has multiple programs to optimize farm production, post-harvest activities, storage, and food safety and to develop new markets for products. One example is the Program of Trade and Markets Development, which aims to build infrastructure for storage and other post-harvest activities. This program provides resources to help producers and buyers commit to a base price in the case of a drop in market price, giving producers an incentive to harvest crops rather than leave them on the field (Sagarpa 2015, 144). In 2014, Sagarpa announced the creation of 16 agro-industrial parks in the country, in the states of Chiapas, Durango, Michoacán, Morelos, San Luis Potosí and Veracruz, with an investment of P$853 million (US$45 million). In this National Agro Parks System, producers of different agricultural-food products share a physical space and collaborate on a shared logistics platform; work together to minimize their energy consumption; maximize production value through technology investments; and increase the competitiveness of the agriculture-food sector (FOCIR-Sagarpa 2015).

Semarnat launched the National Strategy for Sustainable Production and Consumption, in 2013, to promote sustainable production and consumption practices and reduce the economic, social and environmental impacts associated with production and consumption. Included among the public-sector measures to fulfill the strategy's objectives are commitments to: review and update the legal framework regarding sustainable production and consumption; develop economic stimuli to encourage innovation and update technology in production processes; develop and disseminate concepts and educational tools for sustainable production and consumption; and develop the infrastructure for the integral management of waste (Semarnat 2013). Driving this strategy is the pursuit of producing more, with less impact, using approaches that are economically, socially and environmentally sustainable, while avoiding losses at source—including FLW.

Mexico is committed to the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP), a "global framework for action to accelerate the shift toward sustainable consumption and production in both developed and developing countries" (UNEP 2017). The 10 YFP lists the reduction of food losses and waste as an objective under sub-work area 3.2. In conjunction with the 10YFP, Mexico has also signaled its commitment to the UN's Agenda 2030 Sustainable Development Goal (SDG) 12: "ensure sustainable consumption and production patterns." SDG 12.3 includes the specific target to "halve the per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses" by 2030 (UN 2015).

Within individual ministries, the National Crusade Against Hunger, led by Sedesol, brings together three levels of government, as well as other public, social, private-sector and international organizations, with the objective of supporting people living in extreme poverty. The National Crusade Against Hunger created a panel of experts from different ministries of the Mexican government as well as NGOs (DOF 2013). One of the focus areas of the National Crusade Against Hunger is to minimize FLW in the storage, transportation and distribution stages of the food supply chain in central supply markets and retail.

In addition to the above programs already developed, the Mexican Senate received several legislative proposals in 2016 on FLW reduction, such as an awareness campaign on FLW prevention, the creation of a National Council for Food Use (*Consejo Nacional para el Aprovechamiento de Alimentos*) and an evaluation of potential actions to support the Sustainable Development Goals (Senado de le República 2016). These proposals have since been forwarded to specific commissions for detailed analysis.

3.5.4.2 ICI

The System of Integral Measurement and Productivity Improvement (*Sistema Integral de Medición y Avance de la Productividad*—Simapro) is a program aimed at increasing the sustainability of business operations, through an assessment to measure and identify opportunities for improvement (Interview M7). Created by the International Labor Organization (ILO), this program primarily targets foodservice stakeholders, but can also apply to other businesses in the ICI sector. ICI stakeholders have used this program to maximize savings by adding efficiencies to operations, regulating hiring conditions and training employees to reduce plate size and give side dish options. Simapro also recognizes high-performing ICI stakeholders with awards to encourage more sustainable practices by ICI stakeholders. Simapro has been adopted in Chihuahua, Chiapas, Oaxaca, Guerrero and Riviera Nayarit, where it has also been promoted by the Riviera Nayarit restaurant association.

Another way that ICI stakeholders have introduced FLW reduction programs is through multi-national companies that adopt practices from their global parent company. For example, Unilever Food Solutions started a zero-waste initiative in Mexico in 2013 as part of a global initiative. Unilever worked with the National Chamber of Restaurants and Spicy Food Industry (*Cámara Nacional de la Industria de Restaurantes y Alimentos Condimentados*—Canirac) and the Mexican Restaurant Association (*Asociación Mexicana de Restaurantes*) to provide training to members (e.g., restaurants, hotels and chains in the tourism sector) on reduction practices for FLW (Interview M7). Unilever Food Solutions is continuing this campaign, in collaboration with the Mexican Restaurant Association, which provides demo conferences, culinary activities and workshops for members of the Mexican restaurant industry, broaching topics on how to avoid food waste from improper plate presentation, incorrect cuts or inadequate storage (Gutiérrez 2017).

Given the relevance of initiatives on avoiding FLW, government agencies like the Ministry of Tourism have already started addressing the issue, in collaboration with selected hotels (Interview M15), while other agencies such as the Federal Attorney's Office for Environmental Protection (*Procuraduría Federal de Protección al Ambiente*—Profepa) are exploring how FLW reduction could fit into their programs (Interview M16).

3.5.5 United States

3.5.5.1 Government

The Environmental Protection Agency (US EPA) and the United States Department of Agriculture (USDA) have demonstrated their commitment to policies on FLW reduction by calling for the halving of FLW by 2030 (USDA 2015).

In 2011, EPA launched the Food Recovery Challenge, whereby organizations and ICI stakeholders pledge to prevent and divert FLW and report their results. EPA provides technical support, tools and resources, and recognition for outstanding achievements. To date, there are over 950 participants. In 2013, USDA and EPA launched the Food Waste Challenge, calling on organizations and leaders across the food chain to voluntarily commit to reduction, rescue, recovery and recycling of FLW. In 2014, USDA and EPA surpassed their goal of recruiting 1,000 participants by 2020. Following that, in 2016, EPA released a Call to Action that reinforces the support for FLW reduction initiatives. The Call to

Action is rooted in the idea of multi-stakeholder collaboration and taking collective action toward the reduction goal for FLW.

Some of the associated activities and areas of work include the following (US EPA 2016b):

- Seek Prevention Strategies and Use the Food Recovery Hierarchy: By focusing interventions on the prevention of wasted food, and following the principles outlined in the Food Recovery Hierarchy, ICI stakeholders, individuals and organizations can maximize economic gains while increasing social and environmental benefits.
- Increase Public Awareness: Increase consumer and ICI-sector awareness of the scale of the FLW problem, along with the environmental, social and economic benefits of reducing wasted food. This area of work has evolved into outreach through a series of National Summits.
- Clarify Date Labels and Food Safety: Use clear terminology and phrasing to help consumers and secondary users make better decisions about discarding food.

On the policy side, Congresswomen Chellie Pingree proposed the "Food Date Labeling Act" (H.R. 5298) and the "Food Recovery Act" (H.R. 4184). Elements of FLW reduction in these two acts include date-label clarification; education to support reduced waste in schools and throughout federal government, including Congress and the military; and conducting research to identify more ways to better measure and reduce FLW (Pingree 2016). These acts were discussed extensively at a May 2016 House Agricultural Committee Food Waste Hearing, the first session ever to address FLW (Bloom 2016, 18). There is also considerable activity underway to drive FLW reduction at the state level. For example, Oregon State Bill 263 includes waste reduction targets (15 percent below 2012 levels by 2015, and 40 percent below 2012 levels by 2025) and additional waste prevention and re-use program elements for cities with populations over 50,000 (Oregon State Government 2016).

There have also been federal government initiatives to support value-added processing technology. The USDA has a research program through the agency's Agricultural Research Service (ARS), on new processing technologies to use rescued food and byproducts. The USDA ARS collaborates with start-up companies to use promising technologies and help bring them to commercialization and market. Successful technologies that have emerged out of this program have been a part of WholeVine Products (which makes nutritious flour replacement from vineyard waste) and the process for making Just Fruit Bars (bars made only from culled fruit).

3.5.5.2 ICI

In the ICI sector, the FMI, GMA and NRA formed the Food Waste Reduction Alliance (FWRA) in 2011 to coordinate food industry efforts on FLW. This partnership comprises more than 30 manufacturing, retail and foodservice companies, along with anti-hunger, community, and waste-management partners. The FWRA has been promoting FLW reduction to their members and offering resources such as toolkits and case studies, to help encourage members to take action to reduce FLW.

As part of a broader assessment study on food waste, the Natural Resources Defense Council (NRDC) conducted free waste audits and provided customized report summaries, with recommendations for FLW reduction, to ICI stakeholders in Nashville, Denver and New York. The NRDC also launched the Save the Food campaign, in 2016, to promote FLW reduction to consumers, through a widely publicized advertising campaign (in partnership with the Ad Council), public events in a number of cities across the country, and a website with simple day-to-day tips to reduce FLW.

More recently, ReFED launched two online tools aimed at facilitating education and knowledge transfer related to FLW policy and innovators (ReFED 2017d; ReFED 2017e). The Food Waste Innovator Database is a geotagged and categorized set of information that is searchable by action area and geographical area, among other elements (ReFED 2017d). The US Food Waste Policy Finder is a similar concept, with an interactive map of the United States that allows users to explore individual state-level FLW policy or view the cumulative legislative situation (ReFED 2017e). Both of these tools are easily accessible and navigable on ReFED's website, which enables maximum outreach and uptake by consumers and other food system stakeholders.

Further With Food is another example of tools aimed at FLW information sharing and dissemination. This multi-stakeholder initiative seeks to pull together and share high-quality information from various stakeholders about proven solutions and innovative new approaches to reducing food loss and waste. Information resources are submitted to Further With Food and then compiled onto the organization's searchable, user-friendly website (Further With Food 2017).

4 Food Rescue and Recovery

The research team reviewed multiple, published definitions of food rescue and recovery, in order to determine how this term would be defined in the context of this report. The definitions reviewed appear in a table in Appendix 1.

Most definitions of food recovery only include food for human consumption. To align with the scope of this report, animal feed is included in the definition. To differentiate between uses of food for humans versus for animals, in this report food rescue refers to food for humans, and food recovery refers to food for animals. Thus, food rescue and recovery, as applied to this report, is defined as:

> Actions, with or without payment, to receive, store, or process excess, abandoned or rejected food that is safe and nutritious enough to be used for human consumption ("rescue"), and of associated food parts not fit for human consumption but usable for animal feed ("recovery"), which would otherwise be wasted and disposed of.

4.1 Building the Case for Food Rescue and Recovery

Investing in food rescue and recovery has the potential to bring about a range of benefits for different stakeholders in the food supply chain. This section provides an overview of benefits for various stakeholder groups.

4.1.1 Industrial, Commercial and Institutional

For the ICI sector, food rescue and recovery provides an economic incentive to mitigate costs in a market that generally has low profit margins. Surplus food could be sold for a reduced profit to secondary markets or donated, which helps avoid disposal costs. Similarly, where surplus food or food byproducts cannot be redistributed for human consumption, they could be recovered for animal feed, which also avoids disposal costs. In jurisdictions with tax incentives (deductions and/or credits), ICI stakeholders can take advantage of a reduction in taxes, for donating food for rescue.

In addition to the economic benefits, rescuing food provides a mechanism for ensuring that surplus food is still used for human consumption and that the resources that went into producing, packaging and transporting are not wasted. The environmental and social benefits can help ICI stakeholders improve their brand identity and employee morale. Consumers are increasingly interested in more–socially responsible and sustainable practices in the ICI sector, so those that donate food or sell surplus food at a discount could develop a better public image than those known to discard edible food. Within the work environment, the act of discarding food may cause guilt and decrease employee morale. By putting the food to a better use, employees are more satisfied with their jobs, which can lead to better job performance.

4.1.2 Government

The benefits to government from food rescue and wasted-food recovery are similar to those previously listed for reduction of FLW, with regard to environmental benefits (Section 3.1.2), such as reduction in greenhouse gas (GHG) emissions, and conservation of natural resources. One additional benefit of food rescue is that it could provide a stopgap for people who are food-insecure, in times when government resources are limited and unable to support full food assistance (i.e., provide enough nutritious food to fill daily requirements), and could supplement whatever government support is available. This allows the government to stretch its dollars for social programs farther. Also, stimulating the food sector to improve resource efficiency by making full use of food and food byproducts would decrease the burden on government-run waste-processing infrastructure and extend the life of landfills.

4.1.3 Nongovernmental Organizations

The benefits to nongovernmental organizations (NGOs) from food rescue and recovery are similar to those previously listed for reduction of FLW, with regard to advocacy efforts (Section 3.1.3). For food rescue organizations specifically, using rescued food offsets the costs of procuring food. Increasing food rescue can also assist with providing NGOs with more-nutritious and often higher-value items, such as fruits and vegetables, dairy, and proteins. By improving food rescue infrastructure, NGOs can spend more of their resources and funding on providing services to clients rather than on sorting through donations, disposing of spoiled food or coordinating donation pick-ups.

4.2 Challenges to Food Rescue and Recovery

Municipal, regional or state governmental agencies have complementary goals of reducing waste and feeding hungry people. However, competing goals, differing measures of success, and differing funding mechanisms can hamper efforts, especially because recycling FLW is usually less expensive than food rescue and recovery (Mourad 2016). The challenges for food rescue and recovery center around the lack of collaboration among the ICI sector, NGOs and government. Even when there is a desire to increase collaboration, successful and effective partnerships can be challenging to establish among these stakeholders. Trust, in terms of funding and commitment, takes time to develop. Across all stages of the food supply chain, common challenges to food rescue and wasted food recovery include:

- insufficient or inadequate storage space to hold food donations prior to pick up;
- lack of tracking and measurement of quantity of surplus and wasted food available for rescue and recovery, respectively, as well as of the associated savings or cost offsets from donating food; and
- inconsistent interpretation by stakeholders on what types of food are suitable for rescue and recovery.

TABLE 20 presents an overview of the challenges to food rescue and recovery specific to the stages of the food supply chain.

TABLE 20. Challenges to Food Rescue and Recovery in North America

Stakeholder	Challenges to Food Rescue and Recovery
Food Production Post-Harvest	- Labor and transport costs outweigh financial savings - Inadequate resources and coordination
Processing	- Labor and transport costs outweigh financial savings - Inadequate resources and coordination - (Perceived) brand risk - Regulatory constraints and food safety concerns - Competing interests between organics recycling vs. rescue and recovery
Distribution	- Labor and transport costs outweigh financial savings - Inadequate resources and coordination - (Perceived) brand risk

Stakeholder	Challenges to Food Rescue and Recovery
	- Regulatory constraints and food safety concerns
Retail	- Labor and transport costs outweigh financial savings - Inadequate resources and coordination - (Perceived) brand risk - Regulatory constraints and food safety concerns
Foodservice	- Regulatory constraints and food safety concerns - Labor and transport costs outweigh financial savings - Inadequate resources and coordination
Government	- Resource constraints to support food rescue and recovery efforts - Addressing food health and safety issues and concerns
NGOs	- Concerns regarding quality, nutritional value, and managing discards - Inadequate resources and coordination - Regulatory constraints and food safety concerns

4.3 Current Approaches to Food Rescue and Recovery

Various approaches have emerged to address the challenges surrounding food rescue and recovery, as outlined in Section 4.2.

The methodology used to select approaches for this section consisted of a combination of literature review and interviews. Initially, a list of approaches was developed based on the recommendations from reports and conference proceedings on FLW, including the following:

- *A Roadmap to Reduce U.S. Food Waste by 20 Percent* (ReFED 2016)
- *Global Food Losses and Food Waste* (Gustavsson et al. 2011)
- *Wasted: How America is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill* (Gunders 2012)
- *Best Practices & Emerging Solutions Guide* (Food Waste Reduction Alliance 2015)
- *Developing an Industry Led Approach to Addressing Food Waste in Canada* (Provision Coalition 2014)
- Agri Logistics National Program (*Programa Nacional de Agrologistica –Diagnóstico*) (Wageningen UR and Sagarpa 2014)
- Integral Model to Formalize the Labor Base in Productivity Improvement (*Modelo Integral de la Formalización Laboral con Base en la Mejora de la Productividad*) (Rodríguez 2015)
- Challenges and opportunities of the Mexican Agri-Food System for the next 20 years (*Retos y Oportunidades del Sistema Agroalimentario en México en los próximos 20 años*) (Sagarpa 2010)
- Evolution of cold transport in Mexico (*Evolución de la flota de autotransporte refrigerado en México*) (Morales 2016)
- North American Workshop on Food Waste Reduction and Recovery (CEC 2017)
- *Recycling, Recovering and Preventing "food waste": Competing Solutions for Food Systems Sustainability in the United States and France* (Mourad 2016)

TABLE 21 presents common themes found in the available literature, and the eight approaches into which they have been organized. Each approach has a description and a list of food supply stages involved, with those most directly involved indicated in bold. If an initiative was identified as a promising solution across multiple literature sources, it was placed on a shortlist and researched in more detail. For each country, the research team conducted interviews with stakeholders throughout the food supply chain to identify which of the shortlisted approaches would be most promising, from their perspective, and to provide feedback on implementation challenges. Selected approaches are described in more detail in Section 4.4.

TABLE 21. Approaches to Food Rescue and Recovery

Approach	Description	Causes of FLW Addressed by Approach	Stages of Food Supply Chain Involved*
1. Increasing Rescue of Healthy Food	Supporting food banks, gleaning-organizations (they harvest remaining crops in the field), food-rescuing hubs, and meal programs rescuing surplus food: to increase access to nutritious food for food-insecure people.	- Grading standards for size and quality - Inaccurate forecasting of supply and demand - Unexpected fluctuations in demand - Overstocking	- **Post-Harvest** - **Processing** - **Distribution** - Retail - Foodservice
2. Implementing Storage and Transportation Improvements	Expanding temperature-controlled food distribution and storage infrastructure for donated food.	- Cold-chain deficiencies - Improper handling and storage	- Post-Harvest - Processing - **Distribution** - Retail - Foodservice
3. Exploring Financial Incentives for Food Donation	Exploring federal tax incentives for corporations to make food donations, to encourage such donation and educate potential donors on policies.	- Low market prices and lack of markets for second-grade and surplus food products	- **Post-Harvest** - **Processing** - **Distribution** - Retail - Foodservice
4. Developing Liability Protection for Food Donors	Enacting regulations that protect donors from liability for donated food; educating potential donors on existing regulations.	- Food safety concerns	- Post-Harvest - Processing - Distribution - Retail - Foodservice
5. Supporting Online Food Rescue Platforms	Developing online platforms/organizations that support matching of generators of surplus foods to buyers or organizations willing to take donations.	- Low market prices and lack of markets for second-grade products - Inaccurate supply-and-demand forecasting	- Post-Harvest - Processing - Distribution - Retail - Foodservice
6. Feeding Animals	Processing surplus food or food byproducts into animal feed or pet food, or feeding it to animals directly.	- Inaccurate supply-and-demand forecasting - Low market prices and lack of markets for second-grade products - Damage from handling - Trimming and culling	- **Post-Harvest** - **Processing** - Retail - Foodservice

Approach	Description	Causes of FLW Addressed by Approach	Stages of Food Supply Chain Involved*
7. Creating Public-Private Partnerships for Donations	Collaboration to overcome challenges concerning donation, through investments made jointly by the government and private enterprises.	- Employee behavior	- Post-Harvest - Processing - Distribution - Retail - Foodservice
8. Standardizing Donation Regulations, with Regard to Food Safety	Standardizing health regulations for safe handling of donations.	- Food safety concerns	- Post-Harvest - Processing - Distribution - Retail - Foodservice

Six of the eight food rescue and recovery approaches identified in Table 21 above are described in further detail in Section 4.4. Moreover, Section 4.4 links the approaches to the causes of FLW across the food supply chain introduced in Section 2.3. The selection of the six approaches described in detail do not indicate higher priority; rather, they represent a higher frequency of citation in the literature reviewed and were more frequently referenced by survey respondents. The last two approaches were identified in literature sources, but were not as prominent nor described in detail. They are listed in the above table to acknowledge additional approaches that could be used for food rescue and recovery, but further research has not been conducted for this report.

TABLE 22, below, links the six approaches to the challenges introduced in the previous section. A direct link indicates that the approach specifically addresses a challenge, whereas an indirect link presents an opportunity to address the challenge.

TABLE 22. **Linking Challenges and Approaches to Food Rescue and Recovery**

Challenge	Approach					
	1. Increasing Rescue of Healthy Food	2. Storage and Transportation Improvements	3. Financial Incentives for Food Donation	4. Liability Protection for Donors	5. Online Food Rescue Platforms	6. Feeding Animals
Labor and transport costs outweigh financial savings	Indirect—presents opportunity to offset food procurement costs	Indirect—mitigates cost increases by improving storage and transport options	Indirect—presents opportunity to use tax incentives to help offset cost	N/A (Not Applicable)	Indirect—presents opportunity to create another revenue stream through business-to-business recovery (vs. donation)	Indirect—presents opportunity to create another revenue stream to help offset costs
Inadequate resources and coordination	Indirect—as above	Indirect—as above	Direct—offsets transportation costs with tax incentives	N/A	Indirect—as above	Indirect—as above
Perceived brand risk	Indirect—improves public image of food rescue organizations through depackaging/ debranding products; generating positive publicity with donations	N/A	N/A	Indirect—reassures potential food donors, through liability protection	N/A	Indirect—reassures animal feed donors, as products usually consist of a mix of products, so a single brand cannot be identified

Challenge	Approach					
	1. Increasing Rescue of Healthy Food	2. Storage and Transportation Improvements	3. Financial Incentives for Food Donation	4. Liability Protection for Donors	5. Online Food Rescue Platforms	6. Feeding Animals
Regulatory obstacles and food safety concerns	N/A	Indirect—mitigates the risk of contamination or spoilage, through better infrastructure to handle food	N/A	Direct—reduces risk to donors and directly addresses concern through liability protection	Indirect—adds efficiency to transportation of rescued food and can mitigate contamination or spoilage	N/A
Competing interests between organics recycling vs. rescue and recovery	Indirect—provide a specific tactic to promote food rescue and recovery over organics processing	Indirect—avoids spoilage, through efficient systems, and increases food rescue and recovery	Direct—provides a specific tactic to promote food rescue and recovery over organics processing	Direct—provides a specific tactic to promote food rescue and recovery over organics processing	Indirect—provides a specific tactic to promote food rescue and recovery over organics processing	Indirect—provides a specific tactic to promote food rescue and recovery over organics processing
Concerns regarding quality, nutritional value, and managing discards	Indirect—mitigates concerns through policies and practices for what can be donated	N/A	Indirect—includes nutritional content clauses for tax incentives for donation	N/A	N/A	N/A

4.4 Food Rescue and Recovery: Initiatives and Approaches

This section identifies key approaches for food rescue and recovery in Canada, Mexico and the United States, from the perspective of the food industry, government, and nongovernmental sectors. For each approach, current trends, challenges and considerations for implementation are described. Also included with each approach are examples of successful initiatives in each country, as applicable. For select approaches, case studies are included in Section 9.

Key considerations for implementation were grouped into four categories, defined as follows:

- Costs: Additional costs needed to implement approach (capital and operating)
- Savings: Financial savings as a result of implementing this approach (capital and operating)
- Time to implement: Length of time needed to make change operational
- Anticipated level of stakeholder support: The level of buy-in that stakeholders will have for this approach

The potential of each of the considerations was rated according to the scale presented in TABLE 23.

TABLE 23. Ratings Applied to Key Considerations for Implementing Food Rescue and Recovery

Key Consideration	Rating Scale
Costs	Low = low annual cost Medium = medium annual cost High = high annual cost
Savings	High = high cost savings Medium = medium cost savings Low = low cost savings
Time to implement	Short = implementable in the short term Medium = implementable in the medium term Long = implementable in the long term
Anticipated level of stakeholder support	Low = low support by stakeholders Medium = medium support by stakeholders High = high support by stakeholders

4.4.1 Approach 1: Increasing Rescue of Healthy Food

4.4.1.1 Description

In the early 1980s, the concept of “food banks” (a collection of charitable organizations providing food assistance programs) was introduced globally and implemented as a way to provide emergency food relief (Powers 2016, 1). Smaller food rescue organizations, such as soup kitchens (centers that serve prepared food to people in need) and food pantries (community-based organizations that distribute food to their members), were also set up, to provide food to the food-insecure. While there are limitations on food rescue organizations’ ability to provide for long-term food security, there are also potential benefits that can be harnessed, such as increasing access to healthy food while preventing food from being wasted.

Besides food rescue organizations that take donated food, gleaning is another form of food rescue that can provide healthier food alternatives. Gleaning is the process of gathering fruit and vegetables that would otherwise be left to rot or plowed back into the ground after harvesting (Marshman 2015). Gleaning can take place on farms or at urban gardens (e.g., orchards, community gardens).

4.4.1.2 Trends

Food rescue organizations recognize the importance of fresh and nutritious food for their clients and are actively working to increase donations of healthy foods (Interviews U36, C32, C33, C37, M40, C10, C11, U33). Providing food is about not only offering sufficient calories, but also offering the food-insecure a variety of quality foods required for a healthy and nutritious diet (Powers 2016, 3; Interview U7). More organizations now are working with donors to improve the nutritional content of the food provided.

Food donations usually come from large retailers, producers, central supply markets or processors and often include surplus food that cannot be retailed (Tarasuk and Eakin 2005; Interviews M43, U28). On a smaller scale, local markets and restaurants donate to independent organizations (Interview C41). Some food rescue organizations receive food donations directly from farms, if they are in close proximity (Interview U33).

Specific trends in each country are highlighted below.

Canada: There are approximately 4,140 food banks and food rescue organizations across Canada (Food Banks Canada 2016a). Examples of initiatives that focus on healthy food include donation guidelines that consider the nutritional content of food; mandates to provide healthy food to communities; and food literacy programs, such as improving cooking skills, meal planning and budgeting (Interviews C10, C11, C34, C37; BC Centre for Disease Control 2015). The growing trend for formalized fruit-gleaning sees an increase in projects involving harvesting from fruit trees, especially in urban centers across Canada (Edible Garden Project 2010; Not Far From the Tree 2015; Marshman 2015).

Mexico: Mexico has a long history of informal food rescue from different sources, such as central supply markets, local markets and restaurants, due to the high rate of food insecurity in the country, which affects 23 percent of the population (Coneval 2014). In 1995, *Banco de Alimentos de Mexico* (BAMX) was established as the first food bank in Mexico and has become the largest food bank network in Latin America—also the second-largest in the world. BAMX has 60 food banks distributed throughout the country (Interview M44). Independent NGOs also operate food banks, some of which recover a significant amount of food. For example, Food for All (*Alimento para Todos*) recovers about 800 tonnes of food per month (Interview M43). Gleaning also occurs in Mexico, both informally and formally (Interview M44). In the National Crusade Against Hunger, activities have been focused on food rescue through BAMX (Guadarrama-Sistos 2013). BAMX is the primary entity for organizing formal gleaning to harvest crop left in the field after the initial harvest by the farmer.

United States: There are more than 60,500 emergency food providers (e.g., food banks and food pantries) across the United States. Government data counts more than 44 million people in the US who receive nutrition assistance (under programs to provide nutritious foods to vulnerable populations) (Food Research Action Center 2016). In recent years, food banks and anti-hunger organizations started to convene to discuss the issues surrounding nutrition and dignity in the charitable food sector, one such gathering being the Closing the Hunger Gap conference (Powers 2016, 1). Food banks are also starting to take action. Feeding America is developing an End Hunger strategy, which will address nutritional requirements in food donations (Hanner 2017).

4.4.1.3 Challenges and Special Considerations

From a practical standpoint, there are several key challenges to rescuing healthy food (Seattle Public Utilities 2016, ReFED 2016):

- Most foods donated to food rescue organizations are processed non-perishable goods and include products such as snacks and beverages that are high in sugar, salt and fat.
- Retail donors, such as foodservices and grocery stores, cite inadequate cold storage space to keep perishable foods fresh until they are donated.
- The perishability of many fresh donations requires quick turnaround at the food rescue organization and immediate use by the end-recipient.
- Cold-chain management is expensive for food rescue organizations to set up and maintain.
- Some food banks and food rescue organizations do not have cooling infrastructure (i.e., transport and storage).
- Donors and food rescue organizations have difficulty coordinating efficient and reliable pick-up and delivery of donations.

From the donor side, liability is a concern. This concern also applies to farmers, who risk liability of gleaners being injured in the field. While there is legislation in Canada and the United States to protect donors from liability involving food donations, in Mexico the General Health Law includes a provision about liability but specific acts or standards do not exist in detail (Interviews M43, M57). Legislation provides legal protection, but donors still perceive that there may be reputational damage to their brand (e.g., bad press, complaints from receivers of donated goods). This can be a challenge to donating healthy food, which is often perishable and can easily spoil.

To mitigate these potential problems, the onus is often placed on food rescue organizations to invest money, labor and resources in establishing an effective collection, sorting and distribution service (Interviews C30, C37, U30). Infrastructure is necessary to store, refrigerate and transport rescued food. Currently, this infrastructure is lacking, as described in further detail in Approach 4.

In addition to physical resources, food rescue organizations require staff and volunteers to help with operational activities. Due to limited funding, food rescue organizations often rely on volunteers to help with sorting and packaging donations (Interviews C37, M43, U30). Relying on volunteer labor has its own set of challenges, including inconsistent availability, high turnover rates and the burden on staff time for training and supervision.

Specific challenges and considerations in each country are highlighted below.

Canada: In Canada, a key challenge to rescuing healthy food is the amount of resources required to rescue perishable food products across large distances. There are data gaps for how much food loss occurs at the production level and the number of primary processing facilities that could potentially assist in the food rescue efforts. Primary processing facilities are also too far to justify the cost of transport.

Mexico: There are multiple challenges in Mexico to using food rescue to increase access to healthy food. There are inadequate tax incentives to donate healthy food, and no standards to assure that food will be safely handled. At food banks, there are limited staff resources to separate food donations. Instead, it is common for volunteers from vulnerable communities (trained by dieticians) to assemble food pantries (Interview M43). For donors, there is a lack of space to store donated food at central supply markets.

United States: Feeding America found that of households receiving food assistance, 33 percent had a family member diagnosed with diabetes, and 58 percent had a family member with high blood pressure (Feeding America 2014, 119). Low-income households generally rely on foods that are lower-cost, and which contain more refined grains, added sugars and fats. If healthy options that are provided by food rescue organizations are unfamiliar, clients may prefer more commonly known processed foods.

A summary of key considerations for implementing increased rescue of healthy food is presented in TABLE 24.

TABLE 24. Key Considerations for Implementing Approach 1: Increasing Rescue of Healthy Food

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**High**	Additional infrastructure and options for access to healthier food requires transportation, handling and storage effort for perishable food (e.g., fruits, vegetables, meats, fish, dairy). Scaling-up requires significant governmental and philanthropic funding.
Savings (financial savings as a result)	**Low to Medium**	Food rescue organizations could save some costs of procuring fresh and healthy foods but this could be offset by the increased resources required to sort, store and transport perishable donations. For donors, there are some avoided costs of disposal. On a broader scale, healthier eating can contribute to lower government spending on health care, but quantifying such savings would be challenging.
Time to Implement (length of time needed to operationalize change)	**Long**	Changes to the philosophy of food assistance would be required to provide not just calories, but nutritious food, as well as shift how these programs are funded (i.e. public funds vs. charity). Since this is a cultural shift, it would take a longer period of time to educate donors and have them shift their donation practices.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There is widespread recognition from food banks, governmental agencies and NGOs of the need for changes toward healthier food options. Specifically, food provided needs to be nutritious, as opposed to caloric. However, despite recognizing the nutritional challenges, leading food rescue organizations still do not have nutritional requirements for food distributed to their clients and continue to accept and pass on donations of unhealthy and processed foods.

4.4.1.4 Example Initiatives

Canada:

- Food Lens (British Columbia) created a partnership between a school district and Shared Harvest (a food rescue organization that picks up perishables from grocery stores) to use rescued food for a school breakfast program. Through this program, students get to eat a healthy breakfast at school and older students learn cooking skills (Interviews C10, C11).
- The North Shore Culinary School (British Columbia) uses rescued food for a culinary training program that helps students gain employable skills while preparing wholesome meals for social service agencies (Interview C35).
- Various gleaning organizations in Canada, such as Not Far From the Tree (Ontario), have rescued 51,000 kilograms of fruit that would otherwise have been wasted. Under the leadership of York Region Food Network (Ontario), the Fresh Food Partners Gleaning Network partnered with local farmers to provide vegetables and fruits to community members who have limited income (York Region Food Network n.d).

- Volunteer-based groups such as Food Not Bombs (FNB) recover foods that are about to be discarded and transform them into free vegan and vegetarian meals for everyone regardless of income (McHenry 2015).
- The Greater Vancouver Food Bank (British Columbia) works with dieticians to ensure the food it distributes meets nutritional requirements for healthy eating, and hosts community kitchens to help its members gain cooking skills and share recipes for healthy meals (Interview C37).
- Through the +Fresh program, Food Banks Canada developed partnerships with various groups, including Compass Group, to develop a toolkit for starting community gardens, to increase the amount of healthy and fresh foods for its clients (Food Banks Canada 2016b).
- Food retailers in Quebec are involved in the province-wide Supermarket Recovery Program (Programme de Récuperation en Supermarchés), led by Food Banks of Quebec, to donate surplus produce to food banks for distribution to people in need (Kalinowicz 2017).

Mexico:

- The Ministry of Social Development (*Secretaría de Desarrollo Social*—Sedesol) provides economic resources to food banks to hire workers to harvest, in case producers cannot find staff, or harvesting is no longer economical due to low market prices.
- Sedesol has a Program of Rural Supply (*Programa De Abasto Rural*) that delivers food to populations which do not have enough access to basic nutrition. This program covers communities with fewer than 14,999 inhabitants, supporting 24 million people in rural Mexico (Interview M13).
- The Sedesol Liconsa program supplies milk to low-income households, through purchasing surplus milk from farmers at reduced prices (SDPnoticias.com 2016).
- BAMX and Food for All (*Alimento para Todos)* are examples of established food banks in Mexico that recover perishable foods. These initiatives are further explored in Case Study 10 and Case Study 11, respectively.
- The Al Rescate program, created by CMR and supported by the Ministry of Tourism (Sectur), freezes and donates unserved food from restaurants to food banks and to institutions serving vulnerable populations, such as nursing homes and homes for underprivileged children. Of the 134 restaurants in CMR, 107 are participating in this program. In 2015, participating restaurants donated 24 tonnes of food to 12 institutions and 18 food banks (Sectur 2016).

United States:

- Feeding America represents more than 200 food banks in the United States and is developing an End Hunger strategy to address nutritional requirements in food donations. Feeding America also recently purchased a mobile kitchen cart to teach food bank users how to use both new and familiar foods in a healthy manner (Feeding America 2017a).
- The Central Illinois Foodbank (Illinois) found that one challenge to cooking healthy foods is public unfamiliarity with different foods. It teamed up with the Capital Area Academy of Nutrition and Dietetics to lead cooking demonstrations, teaching food bank users how to cook new foods and prepare familiar foods more healthfully (Feeding America 2017a).
- City Fruit (Washington) uses volunteer gleaning of urban fruit to provide fresh, healthy produce and harvests over 13,000 kilograms annually, across five neighborhoods (City Fruit 2014).
- DC Central Kitchen (Washington, DC) and L.A. Kitchen (California) are nonprofit and social enterprises that use rescued food to create healthy meals and snacks and distribute them to areas with low food security. In addition, they offer a free culinary job training program for at-risk youth and adults. This initiative is further discussed in Case Study 12.

- The Daily Table (Massachusetts) is a grocery store in Boston that only sells food that is close to the sell-by date or past its best-before date but that is perfectly edible and healthy (Boesveld 2013). This initative is further discussed in Case Study 13.
- The California Association of Food Banks: Farm to Family (California) created a program that covers the cost of labor, handling, packaging, refrigeration and transport for harvesting unmarketable produce alongside market produce. This allows the rescue of 55,000 tonnes of “ugly” produce per year, which is collected from farms and processors and distributed to food banks throughout California, while growers are able to deduct the charitable donation (Gunders 2012).
- Food for Free (Massachusetts) repackages items into complete balanced meals and distributes them in partitioned trays (Food for Free n.d.).
- Wholesome Wave (Connecticut) is a nongovernmental organization that supports the creation of medical prescriptions for fresh produce for people in danger of malnutrition. It is now looking to expand its network and support other organizations in achieving their food provision goals (Paynter 2017).

4.4.2 Approach 2: Storage and Transportation Improvements

4.4.2.1 Description

Food banks rely on non-perishable and perishable food donations that are close to expiry, overstocked, mislabeled, discontinued, discounted or have damaged packaging. In the case of fresh fruits and vegetables, food banks rely on produce that is close to being overripe or cannot be sold due to imperfections. Meat, seafood and dairy products are also perishable items that are of high value to food banks due to their nutritional qualities, but are challenging to handle because of their need for proper cold-chain management to reduce spoilage and contamination.

Storage capacity is a critical issue for food banks, which need to efficiently serve and be able to increase the number of clients they can help. Most food banks highly value produce, protein and dairy donations because of scarcity and the nutritional value to their clients. For instance, dairy items are the least frequently donated food category, but the most needed by food banks (Interview U29). Sought-after items often require cold storage to maintain quality and safety, and food banks typically lack sufficient cold storage equipment to receive and preserve large donations (Seattle Public Utilities 2016).

Sharing or consolidating infrastructure for storage and transportation of food donation could reduce the need for cold storage units and transportation vehicles at every food bank and related agency. By having additional storage capacity, donated food stock becomes much more manageable and allows food banks to take advantage of sale prices for high-demand items in larger quantities without displacing older stock so it can be used first before it spoils (Food Banks Canada 2014). In Canada and the United States, transportation networks and cold-chain management of food donations are more established. In Mexico, there are still significant changes that need to be made in the distribution sector of the primary food supply chain before it can be adapted to rescued food.

4.4.2.2 Trends

To most effectively accommodate the rescue and distribution of perishable foods, large urban centers are operating food rescue hubs, whereby one organization is dedicated to the food rescue operations while the smaller food banks and food transformation agencies (e.g., community kitchens, meals providers) collect the perishable food from the central location (Interviews C32, C33, C37, U33).

Due to the desire from food rescue organizations to have more-nutritious food, there is a trend toward increasing the amount of nutrient-dense, perishable donations such as meats, dairy products, fruits and vegetables. Food banks can no longer rely on volunteer vehicles and volunteer labor to transport food donations. Larger food banks have been investing in perishable-food rescue programs, such as recovering meat and fish from grocery stores, which requires a capital investment in infrastructure for cold trucks, repackaging equipment and cold storage (Interviews C32, C33, U36).

Sharing of such resources is becoming more common, with larger food rescue organizations acting as the interface between the ICI stakeholders with surplus food and the users (e.g., meal programs, community kitchens, food pantries). Larger organizations, with more-sophisticated trucks and resources, are capable of rescuing surplus perishable food closer to the source, which makes it more convenient for donors (e.g., at the farm) (Interview C33). These larger organizations are also working with donors on bulk donations (multiple pallets) direct from distribution centers, to maximize efficiency, since picking up one large donation involves the same operational overhead as picking up from a grocery store or restaurant, but the yield is significantly greater. Once at the warehouse, the larger food rescue organizations can redistribute food donations in smaller quantities to users.

Specific trends in each country are highlighted below.

Canada: Almost two-fifths (38 percent) of food distributed by Canadian food banks is fresh; examples are milk, eggs, fruits and vegetables, and bread. Most of the donated food is supplied by retailers as part of the Retail Food Program, operated by Food Banks Canada (Food Banks Canada 2016b). Food donations are also supplied by food processors, distributors and foodservice companies. In recent years, larger food rescue organizations and food banks, such as Second Harvest and Moisson Montréal, have been upgrading their operations with more-advanced logistics planning and cold-chain management, to deliver food to smaller food distribution organizations (Interviews C32, C33). This alleviates the need for smaller organizations to transport and store their own food in large quantities.

Mexico: Sedesol has a Fund for Contributions for Social Infrastructure (*Fondo de Aportaciones para la Infraestructura Social*) that provides funding to build food bank facilities or improve equipment (Interview M60; Sedesol 2016).

United States: The largest model for collecting and distributing food donations is managed by Feeding America, which has approximately 200 regional and city food banks across the country (Feeding America 2016). In the last 20 years, these food banks have increased their scale and ability to store and distribute rescued food, but still face challenges in the ability to make the capital investments required for transportation and cold storage. However, as food rescue is growing in the United States, food donors are starting to realize the importance of transportation and some are willing to make the investment in order to increase food donations. One major American food manufacturer stated that it might consider incurring losses associated with transportation for donating food, as part of its social commitments (Interview U38).

4.4.2.3 Challenges and Special Considerations

The challenges around efficient transportation and reliable storage of rescued food are different at each point of generation and distribution. Getting food from donor to user revolves around several factors, including transportation time, conditions of transportation vehicles (e.g., truck temperature and humidity), and availability of storage space to hold food for the food rescue organization until it is picked up by a user.

Even with the transportation and storage infrastructure in place, organizations must ensure that quality control standards are in place for every donation. These standards can vary among organizations, which may lead to food being wasted if a product is acceptable to one organization (e.g., a large food rescue distributor), but not acceptable to another (e.g., a meal program). The donated food must be inspected by the drivers and in some cases recorded, to ensure that what is being donated is suitable for eating and not just being donated as an alternative to disposal (Interview C32). Drivers must evaluate the quality of the product to ensure it is not spoiled, which is a common occurrence (Interview C32).

Although consolidation and coordination of transportation allows for more short-distance, small-load transportation, it is more expensive per kilogram of rescued food compared to long-haul transportation. Due to small volumes, collecting donations from individual donors, such as restaurants, hotels and cafeterias, can be financially infeasible. For some agencies, the resources needed to acquire the donated food are worth more than the value of the food. Another challenge with transportation and storage improvements is that food rescue organizations often bear the capital costs for warehouses and trucks, and operating costs for facility maintenance and labor.

Specific challenges and considerations in each country are highlighted below.

Canada: Although larger food rescue organizations are helping broker donations and transport food donations to smaller organizations, the donations received from them by smaller organizations are not always of the highest quality (Interview C32). Although these donations can be rejected, these smaller groups can run the risk of losing donations altogether if they refuse low-quality items from their larger counterparts (Interviews C10, C11, C32, C33, C37).

Mexico: Storage and transportation infrastructure in the primary food supply chain is already limited, so potential donors will prioritize using available resources for products that will generate revenue over using them for donations. Due to limited storage, available space is prioritized for new merchandise, which leaves minimal remaining footprint for storing donations until food banks or other food rescue organizations can pick them up (Interview M67). This happens mainly in central supply markets, where daily food trading is highly dynamic.

United States: Transportation challenges can stretch regionally across several states or, on the smallest scale, between a restaurant and a soup kitchen in the same neighborhood. For example, of both large and small restaurants surveyed across the United States, 78 percent reported that transportation constraints limited their food donations and 67 percent stated that insufficient storage at food banks limited their ability to donate food. For retail and wholesale sector, 69 percent cited both transportation restraints and storage (BSR 2014). Although some donors in the United States share tax incentives to cover the transportation and distribution costs, that is not yet a widespread practice. With tight budgets, and reliance on inconsistent funding through grants, donors and foundations, committing to regular collection runs that have cold-chain management is difficult. Larger corporate manufacturers are typically willing to arrange for transportation with Feeding America and regional food banks, but the cost of shipping can limit the distance and number of recipients.

A summary of key considerations for implementing the approach of improving storage and transportation is presented in TABLE 25.

TABLE 25. Key Considerations for Implementing Approach 2: Improvements to Storage and Transportation

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**High**	For food rescue organizations and NGOs with limited budgets, the cost of upgrading or expanding storage capacity and of procurement of cold trucks is very high.
Savings (financial savings as a result)	**Low**	Food rescue organizations would avoid some cost for disposal of donations that spoil due to inadequate facilities. But this is low compared to the capital and operational costs of cold-chain management, which donors generally will not fund. Companies donating the food benefit from reduced disposal of surplus

Key Consideration	Rating	Explanation of Rating
		products.
Time to Implement (length of time needed to operationalize change)	**Medium**	Food rescue organizations will need to fundraise or apply for grants to upgrade their infrastructure, and then go through a procurement process and training for staff. There is also time needed to identify donors of perishable products, educate donors and employees at their workplaces, on cold-chain management of donated foods, and establish collection logistics.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There is high buy-in from food rescue organizations. However, they rely on donors to invest in the infrastructure, which is not in the donors' primary interests, and on staff and volunteers to assist with handling these donations.

4.4.2.4 Example Initiatives

Canada:

- Second Harvest (Ontario) is the largest food rescue organization in Canada, having over 220 centers in its network. It uses seven refrigerated trucks and two vans to collect and deliver perishable foods (e.g., fruits, vegetables, dairy, breads, meats) within a 24-hour turn-around time so that good food does not go to waste (Interview C33).
- The Rosetown & District Food Bank (Saskatchewan) has benefited from new cold-storage installations that increased its storage capacity by 30 percent; this upgrade makes its stock more manageable, and allows the use of older stock and of taking advantage of sale-priced high-demand items (Food Banks Canada 2014).
- Moisson Montréal (Quebec) collects perishable foods in Montreal and re-distributes them to over 250 agencies throughout Quebec that provide meals to people in need (Interview C32; Moisson Montréal 2015a). This initiative is further discussed in Case Study 14.
- LeftOvers (Alberta) delivers perishable food to charities throughout Calgary that provide meals to people in need.
- Greater Vancouver Food Bank (British Columbia) has a Food Runners program that collects perishable foods, manages 13 distribution locations and provides food to about 100 community agencies located in Vancouver, Burnaby, New Westminster and North Vancouver (Interview C37).

Mexico:

- Sedesol has a Fund for Contributions for Social Infrastructure (*Fondo de Aportaciones para la Infraestructura Social*) that provides funding to build food bank facilities or improve equipment (Interview M60; Sedesol 2016).

United States:

- The Borderlands Food Bank (Arizona) transports approximately 18,000 tonnes of rejected produce to hunger-relief organizations at an affordable rate (US$0.04 per kilogram of product), which makes it feasible to rescue perishable foods (ReFED 2016).

4.4.3 Approach 3: Financial Incentives for Food Donation

4.4.3.1 Description

The financial incentives for food donation are tax deductions (reduction in taxable income used to calculate taxes owed) or credits (direct reduction in the amount of taxes owed) that are issued to donors for rescuing food for charities (Harvard Food Law and Policy Clinic 2017). Usually the incentive is based on the equivalent value of the donated food, typically as a percentage of the fair market value. Tax incentives can be legislated at a state/provincial or federal level.

Policies that support and regulate donations of edible food for rescue have become important components in re-distribution of food and therefore they help prevent perfectly healthy and edible foods from being composted or wasted in landfills, as well as assist those who are hungry. In this section, the focus will be on tax incentives for donation, as this is currently one of the most common regulatory tools applicable to food donation (Harvard Food Law and Policy Clinic 2017). Tax incentives provide additional financial benefits to donors, in addition to avoided disposal costs, and can promote food donation.

4.4.3.2 Trends

In each of the North American countries, there is some form of tax incentive for food donations, at a state/provincial or federal level. Specifics on these types of regulatory tools are further explained in each country's subsection.

Canada: Tax incentives for farms and food producers are currently in place in four of the thirteen provinces and territories:

- The Province of Ontario has taken a first step in providing tax relief for food donations, by enacting the Local Food Act, in 2014; the Act provides tax credits to farmers who donate fresh food to local food banks. The tax incentive provides farmers with a 25-percent tax credit based on the fair market value of food being donated to food banks and/or community meal programs (Ontario Association of Food Banks 2012).
- British Columbia enacted a tax credit similar to Ontario's, for food donations from farmers (25 percent tax credit), but only for a trial period from 16 February 2016 to 1 January 2019 (Government of British Columbia 2016).
- Nova Scotia enacted a tax credit similar to Ontario's, for farmers for donations made to a registered food bank (25 percent tax credit) (Government of Nova Scotia 2016).
- Project Protein is being piloted in Alberta to encourage cattle and hog farmers to donate animals to their local food bank, in exchange for a charitable tax receipt equivalent to the fair market value of the animal (NZWC 2015).

There is currently no tax incentive legislation at the federal level.

Mexico: The Federal Income Tax Act, Article 27 has a general clause for tax credits for donations of basic goods (including food) to qualified nonprofit organizations such as charities, as outlined in Articles 79, 82 and 83 of the law (DOF 2016). Qualified nonprofit organizations are registered by the Tax Administration System (*Sistema de Administración Tributaria*—SAT). Food banks issue tax receipts to donors for 5 percent of the commercial value of the donated food (Interview M44). Donors then receive a tax credit from the SAT (Interview M43). Donors are required to track donations before food is removed from inventory.

At the level of local government, the government of Mexico City passed the Altruistic Food Donation Law, which is intended to promote, guide and regulate donation of food suitable for human consumption while preventing food waste (Gaceta Oficial de la Ciudad de México 2017). Government programs to support food bank activities include funds for temporary employment to harvest crops when farmers cannot afford to pay staff due to low market prices. Although this type of subsidy is not necessarily a tax incentive, it is a way to help offset the costs of food rescue. Another indirect financial incentive for food banks is that in 2016 they were exempted from limitations on the use of automobiles on the specified days stated in the Not Driving Today Program (*Programa Hoy No Circula*) in the Metropolitan Zone of the Mexico Valley (Hoy No Circula 2016), which allows them to recover and distribute food daily.

United States: Donation tax incentives are by far most developed in the United States, compared to in Canada and Mexico. Nationwide, for rescuing food for charities, donors qualify for a tax deduction equivalent to "twice the basis of the donated food" or "the basis of donated food plus one-half of the food's expected profit margins" (Harvard Food Law and Policy Clinic 2017). According to Feeding America, tax relief legislation resulted in doubling of food donations by companies from 2005 to 2008 and a 137-percent increase in ICI donors since 2006. Currently, the food manufacturing and retail sector in the United States contributes 54 percent of food donations (Feeding America 2015).

4.4.3.3 Challenges and Special Considerations

While tax incentives for food donors have been proposed, their effectiveness in increasing food donations remains uncertain. There are concerns over tax incentives, from a food security standpoint. Scholars, activists and some food rescue organizations are concerned that incentivizing food donations will enable food companies to indiscriminately use food banks and other food rescue charities as a dumping ground for unwanted and, possibly, inedible food (Tarasuk 2015; Powers 2016; Mourad 2016; Interviews U30, C29, C36). Currently there are no laws in each country that require that to receive a tax benefit there must be a minimum quality or nutrition standard for food donations, which leaves charities exposed to the risk of receiving undesirable donations, while donors continue to receive a tax benefit. Although charities can decline donations, doing so can jeopardize their ability to receive donations in the future from the same donor and often donations include a mix of items that cannot be partially rejected (Interview C37).

Furthermore, tax deductions or tax credits for donating food may not promote efficient food systems, and could end up perpetuating wasteful practices across the food supply chain. The need for tax deductions and tax credits can also be challenged, given that many companies and businesses already donate surplus food in the absence of financial incentives. A deeper analysis should be undertaken to evaluate whether or not financial incentives are appropriate in each country.

Potential benefits may not be realized if neither the benefactor nor the community food organization has supporting infrastructure. Storage, refrigeration and transport infrastructure, labor cost, restrictive waste policies, lack of funding, large amounts of poor-quality donated foods, and the permits needed for premises are just a few of the challenges faced by food banks and food rescue organizations. Food charities may not be in a position to handle or want the enormous amount of food that might be suddenly offered to them (e.g., low-nutrition food, or perishable foods that require cooling) (Azpiri 2015; Powers 2016). Mixed-stream and non-nutritious donations take a significant amount of time, from volunteers and staff, to process and then to dispose of. There can be cases where contamination in the donation requires that the entire stock of food be de-packaged and disposed of, all with limited staff and financial resources. Food banks can lose money and waste volunteer hours because of receiving too many unusable donations (Lovgreen 2016). In addition, food banks can be put in the difficult position of risking losing future donations if they reject donations of unusable food. The current model of tax incentives for food donations does not include provisions to help food banks and food rescue organizations with the infrastructure and resources needed to process food donations, nor does it help with better quality control. It is therefore necessary to recognize the importance of pairing regulatory reforms with infrastructural considerations.

Another consideration that could be a deterrent for food donors, in taking advantage of tax incentives, is low-cost disposal. If it is cheaper to landfill or compost edible food rather than to donate, it is likely that companies would continue to choose the cheaper option.

Regardless of the financial savings of a tax benefit for donations, many potential corporate donors are highly protective of their brand and are risk-averse toward anything that might compromise their reputation (Interviews C16, U2, U8, U39). Consequently, if they think donated products could be identified as their brands and these products have less quality or poorer aesthetics than their customers are used to, they often err on the side of not donating (Interviews U8, U39). These fears appear to be unfounded, as no lawsuits have been documented against a donor, up to 2013 in the US (UARK 2013) and 2015 in Canada (BCCDC 2015). Outreach to the private sector, and education, by the government and private charities, may assist in overcoming this limitation.

Specific challenges and considerations in each country are highlighted below.

Canada: An example of the costs associated with handling food from donations is the case of Greater Vancouver Food Bank, which spends roughly US$30,000 per year putting unusable donated food through the waste stream because it cannot be distributed (Lovgreen 2016). Although there is an opportunity to propose a tax incentive that donates a portion of the credit back to charities to handle food donations, this is not currently included within the scope of the federal tax incentive proposal for food donation.

Mexico: Tax incentives for food donations are very low compared to those in Canada and the United States; to address this challenge, Sedesol has explored improvements to the potential tax benefits for donors, as a means to encourage more donations (Interview M44).

United States: In a survey of comparable US food manufacturers, retailers, and wholesalers, half of respondents cited insufficient storage and refrigeration at food banks and a lack of cold trucks and drivers as challenges to donating food (BSR 2013). In order to facilitate food donations and to bolster the effectiveness of tax credits, capital grants could be provided to improve transportation and storage infrastructure.

Although tax benefits have increased the amount of corporate donations, often only large corporations have the resources to take advantage of such benefits, due to the administrative overhead required to track donations for a tax deduction. The tax reform in 2015 was important because it allowed more small and medium-sized enterprises to claim tax benefits. However, there are still challenges at the state level, such as a recently passed food donation state tax credit in California that requires an inventory-based method of valuation. The issue with this method is that it is only accessible to large farming operations with well-established record-keeping practices (ReFED 2016, 44).

A summary of key considerations for stakeholders for implementing the approach of financial incentives for donors is presented in TABLE 26.

TABLE 26. Key Considerations for Implementing Approach 3: Financial Incentives for Food Donors

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium to High**	For food donors, if they do not already have a system for food donation storage and tracking, then capital investment would be needed for set-up as well as operational funds to run the food donation program. For food rescue organizations, there is an additional operational cost to transport, receive, and store more donations, especially if they are unusable or require sorting by staff or volunteers. Primarily, it is the NGO sector that will bear these costs. In some cases, ICI

Key Consideration	Rating	Explanation of Rating
		stakeholders will invest in transportation and storage for donations, but that is not the norm.
Savings (financial savings as a result)	**Low to Medium**	For donors, there could be some cost savings by increasing food donations since with it some disposal cost would be avoided. However, there is still a brand risk for companies (which can result in loss of sales). Furthermore, an opportunity to sell food to secondary markets has better financial benefit than donations. Food rescue organizations might see savings by not having to buy as much food. They could, however, end up having these savings offset by having to pay more to dispose of unwanted food that results from policies to increase food donations.
Time to Implement (length of time needed to operationalize change)	**Long**	In each country, there has already been much discussion and federal legislative action to do with tax and donation regulations, but codification and implementation will take time. The degree of debate would indicate that getting stakeholders to come to agreement on a policy framework and proposed changes to regulations will be a lengthy process.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Low to Medium**	Donation policy has received a lot of attention and many stakeholders are interested in simplifying, clarifying and streamlining rules for food donations. However, there is not general agreement among stakeholders on what the best approach should be and it is unclear if investing in donation policy is the best way to increase food rescue.

4.4.3.4 Example Initiatives

Canada:

- Under the Ontario Local Food Act, 2014, farmers receive a 25-percent tax credit based on the fair market value of food donated (Ontario Association of Food Banks 2012).

Mexico:

- The Federal Income Tax Act, Article 27, has a general clause for tax credits for donations of basic goods (including food) to qualified nonprofit organizations such as charities, as outlined in Articles 79, 82 and 83 of the law (DOF 2016).

United States:

- The Internal Revenue Service and Protecting Americans from Tax Hikes (PATH) Act, 2015 contains a tax code allowing corporations to claim enhanced tax deductions for food donations to 501(c)(3) NGOs that feed hungry people. Donating organizations have had difficulty in determining the fair market value of the donated food.

- Food Cowboy is able to deduct 50 percent of the fair market value minus the cost of goods when excess food is donated instead of sent to landfill (Interview U32). This initiative is further discussed in Case Study 16.

4.4.4 Approach 4: Liability Protection for Donors

4.4.4.1 Description

Liability protection for food donors is a regulatory tool that protects donors from being sued for damages if a consumer of a food donation becomes ill, as long as the food was appropriately donated and properly vetted.

4.4.4.2 Trends

Liability protection for food donors exists in the United States and Canada, but not in Mexico.

In the United States and Canada, the fear of liability is decreasing as food donation becomes more mainstream and so do outreach and awareness campaigns on laws that protect donors. Companies that are interested in donating are often unaware of liability protection, but once they are informed their fears are often alleviated. Donors are also recognizing that food rescue saves money because less management is needed for disposal of surplus food, and the fees paid for waste tipping are reduced (Interview C33).

The following subsections describe the relevant legislation and outreach efforts in each country.

Canada: Every province and territory in Canada has enacted its own food donation laws that protect donors from liability. For example, in Prince Edward Island, a Food Donation Act has been in place since 1988, while in 2013 Nunavut became the most recent territory to adopt a law to protect food donors. In general, these laws exonerate any individual from legal liability for donating food except under certain conditions, such as donation of food with an intention to cause injury or death to the recipient, or donation done with reckless disregard for public safety.

To promote and clarify liability protection, organizations—including the National Zero Waste Council, Second Harvest, and BC Centre for Disease Control—have developed guidelines and outreach materials to help potential donors understand how they are covered under liability protection laws (BC Centre for Disease Control 2015; Second Harvest 2014; NZWC 2015).

Mexico: In Article 199 BIS of the General Health Law, organizations that receive, supply or distribute food donations are subject to health and safety standards. They are held responsible for harm/illness caused by donated food if there was intentional misconduct (e.g., knowingly giving out spoiled food) (DOF 2007). This law does not explicitly offer liability protection for donors; however, it does put the onus on food rescue organizations to ensure donated food is safe to consume.

United States: The Bill Emerson Good Samaritan Food Donation Act of 1996 encourages food donation to NGOs, and exempts donors from liability for injury arising from consumption of the donated food as long as there is no gross negligence or intentional misconduct and donations are made in good faith (US Government Publishing Office 1996). This act was enacted federally and applies nation-wide.

Education and outreach efforts on liability protection for donors have been undertaken by numerous organizations that have national operations, like Feeding America and Food Donation Connection, who host websites and actively promote the Federal Bill Emerson Good Samaritan Food Donation Act to the public and to corporations in particular (Feeding America 2017b; Food Donation Connection 2015). There are also a number of local organizations and universities—like the Second Harvest Food Bank, of Southern Wisconsin, and the Public Health Law Center, at William Mitchell College of Law—that have pages or reports on their websites outlining food-donor liability protections (Second Harvest Food Bank 2017; Public Health Law Center 2013).

4.4.4.3 Challenges and Special Considerations

The liability protection laws in Canada and the United States have never been tested in court, so although the protection exists, there is uncertainty about the outcome should a case ever come to be tried. No lawsuit has been documented against a donor, up to 2013 in the US (UARK 2013) and 2015 in Canada (BCCDC 2015). .

Regardless of the legal liability protection that exists, potential corporate donors are highly protective of their brand and risk-averse toward anything that might compromise their reputation (Interviews C16, U2, U8, U39). Consequently, if they think donated products could be identified as their brand and these products have less quality or poorer aesthetics than their regular products, they often err on the side of not donating (Interviews U8, U39). In other words, for donors the brand risk may be greater than the legal risks. Outreach to the private sector and education by the government and private charities may assist in overcoming this limitation. Specific challenges and considerations in each country are highlighted below.

Canada: Despite the existence of education and outreach materials on liability protection (Section 4.4.4.1) in Canada, there is still a general concern over liability for food donations. An added challenge that has been identified by the foodservice sector in Canada is the misuse of food donations, which could result in a brand's being tarnished not because of the quality of the product donated but because of mishandling by food rescue organizations (Interview C16).

Mexico: The key challenge in Mexico is that explicit liability protection for donors does not exist. Legislation on food rescue focuses on protecting the end-consumer instead of the donor.

United States: Despite the existence of the Emerson Good Samaritan Act, donors still generally have limited knowledge about laws protecting them from food safety liability when they donate. In particular, large manufacturers and corporations tend to have higher concerns over potential liability (Interviews U36, U38). In a survey of restaurants and other foodservice establishments in Northern California, 75 percent responded that they do not donate food because of liability concerns (Interview U2). Therefore, there is still a significant amount of education and outreach that is needed in order for potential donors to understand liability protection.

A summary of key considerations for stakeholders for implementing the approach of liability protection for donors is presented in TABLE 27.

TABLE 27. Key Considerations for Implementing Approach 4: Liability Protection for Donors

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Low to Medium**	Potential donors can set up a food donation program with minimal costs, which include some labor for coordination, and space for storing donations. For food rescue organizations, there may be additional operational costs to transport, receive, and store additional donations from new donors.
Savings (financial savings as a result)	**Low to Medium**	Donors can avoid disposal costs by starting a food donation program or increasing the number of donations. However, surplus foods that can be sold to secondary markets would create more financial value than donations. Food rescue organizations may financially benefit by reducing food procurement costs through more donations, but these savings may be offset by increased sorting and disposal costs of spoiled or unwanted donations.

Key Consideration	Rating	Explanation of Rating
Time to Implement (length of time needed to operationalize change)	**Long**	Already implemented in Canada and United States. In Mexico, due to the degree of debate on proposed changes to regulations on donations, it is likely that the process for stakeholders to come to agreement on a policy framework will be lengthy.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	Donors are generally reassured once they understand liability protection laws, but are still cautious about non-legal risks of donating food (e.g., brand risk, bad publicity).

4.4.4.4 Example Initiatives

Canada:

- Each province and territory has its own Food Donation Act that protects donors from legal liability when making food donations. Food Banks Canada displays links to all of the provincial and territorial "Good Samaritan Acts" on its website (Food Banks Canada 2017).
- The BC Centre for Disease Control has created a comprehensive donor outreach package that outlines liability protections among other information to guide companies through the food donation process (BC Centre for Disease Control 2015). This initiative is further discussed in Case Study 15.
- Second Harvest has also created a "Food Donor Info" package, which outlines food safety, date labeling, and logistical/procedural and liability protection information for food donation and acts as a handbook for ICI stakeholders looking to donate surplus food (Second Harvest 2014).
- The National Zero Waste Council is an active advocate for FLW reduction in Canada, and its activities include hosting a working group, promoting national policy options, and outreach to companies regarding food donor tax incentives and liability protections (NZWC 2015).

Mexico:

- Article 199 BIS of the General Health Law dictates health and safety standards and assigns responsibility for liability to organizations that receive food donations, but does not explicitly offer liability protection to donors (DOF 2007).

United States:

- The Bill Emerson Good Samaritan Food Donation Act (1996) exempts donors, individual or organizational, from liability for injury arising from consumption of the donated food as long as there is no gross negligence or intentional misconduct and donations are made in good faith (US Government Publishing Office 1996).
- The Campus Kitchens Project is heavily involved in food rescue, as it primarily uses rescued surplus food for its operations in communities across the country. As such, it has part of its website dedicated to education and outreach regarding the Good Samaritan Food Donation Act, in the form of FAQs (Campus Kitchens Project 2017).
- FoodShift also has part of its website dedicated to explaining relevant portions of the Good Samaritan Act for food donors. Additionally, through social media (specifically Twitter) it actively spreads information about liability protections for food donation (FoodShift 2017).
- Feeding America is a large NGO that also engages in outreach and education regarding the Good Samaritan Food Donation Act. It dedicates part of its website to outlining the relevant

legislation for potential food donor companies along with other pertinent logistical and financial incentive information (Feeding America 2017).

4.4.5 Approach 5: Online Food-Rescue Platforms

4.4.5.1 Description

Online food-rescue platforms are providing an opportunity to match donors to recipients and track food donations. The ubiquity and ease of use of mobile technology makes it easier to facilitate direct connections between donors and recipients in a marketplace-type setting (Kane 2015). Online platforms are primarily focused on tackling two specific issues:

1) organizing the transportation and distribution piece of the equation, which can render a food donation program uneconomical; and.
2) reducing the reliance on intermediaries, such as large food rescue organizations, to connect donors to users or provide transportation logistics.

Some online platforms provide transportation, whereas others rely on the users, volunteer drivers, donors or paid drivers for transportation (Kane 2015).

Online platforms increase the viability of recovering food from smaller donors. For food rescue organizations, transportation costs for donations weighing under 20 kilograms are much higher than for large donations. Online platforms have the potential to make it easier to design and execute "milk runs" of multiple, smaller pick-ups on a route, making this more cost-effective (ReFED 2016).

With an online platform, donation tracking is more streamlined, to take advantage of tax benefits which in the past were limited to larger donors with existing tracking systems. Similarly to traditional donation-matching platforms, online platforms use the tax benefit to drive the financial component of financing the donation (Feeding America 2016). Technology providers usually charge a commission for each transaction (e.g., connection between a donor and recipient) or receive a portion of the tax benefit from the donor as payment (Interview I1).

This approach of using online food-rescue platforms is taken in the context of Canada and the United States, where such platforms have been developed. These types of platforms have not yet been extensively developed in Mexico.

4.4.5.2 Trends

Online and mobile technology solutions are emerging to fill a variety of niches for food rescue efforts across Canada and the United States. Because many of these solutions are only available in metropolitan areas, their reach and impact are not yet national, but the number and variety of software solutions available on websites and often as smartphone apps are increasing quickly.

Because many of the online platforms are nascent in development, or simply have limited geographic reach, quantitative data from the developers are largely unavailable.

Specific trends in each country are highlighted below.

Canada: Most online food rescue platforms in Canada are still in the development phase, and are localized geographically. Like other online platforms, they require a critical mass of users to function properly, and therefore are located in larger urban centers like Vancouver and Montreal.

Mexico: There are no documented online food-rescue platforms in Mexico. However, an example of an online platform that helps food banks with improving operational efficiency is software developed by the Center for Research in Food and Development (*Centro de Investigación en Alimentación y*

Desarrollo—CIAD) and the Monterrey Institute of Technology and Higher Education (ITESM) (Interview M70).

United States: ReFED (2016) estimated that online platforms have the potential to recover 135,000 tonnes of food, with an economic value of US$432 million and equating to 250 million meals, although they also warn that "actual use cases are breakeven or very low profit" (ReFED 2016, 46; Interview I1).

4.4.5.3 Challenges and Special Considerations

The challenges for nearly all the online platforms are similar:

- they need to achieve sufficient scale to create interest, geographic coverage and have impact;
- transportation costs need to be sufficiently below the value of the tax benefits; and
- transaction documentation should be easy to convert into tax deductions or credits (where applicable).

Currently available online platforms are established in a few municipalities and are still scaling up to create a robust marketplace offering variety, size and geographic coverage. To become a routine part of operations for both food donors and food rescue recipients, the transaction must be easy and reliable, which is not always the case with the current systems (Interview U32).

Similarly to technological solutions in other arenas, new online platforms also must convince their users to learn different processes. Recipients of food donations may need to adjust to the varied, less consistent and smaller donations possible from online platforms. Both donors and recipients may need training and adjustment to familiarize themselves with a new technology platform (ReFED 2016). Small donations also have issues related to cost and timeliness of pickup and delivery (Interview U31). In addition, some transportation must ensure proper cold-chain management.

Specific challenges and considerations in each country are highlighted below.

Canada: The challenge for all online apps is the potential for miscommunication and missed expectations. There is also a concern amongst potential donors that there is liability involved in participating. Lastly, shifting the culture to use of online applications can be challenging for less technologically savvy users. As well, online platforms may possibly remain inaccessible to many potential users for some time (Interview C48).

Mexico: Although there are no known, online food-rescue platforms already developed in Mexico, the current research has not identified any specific reasons why an online app would not be a useful tool there. While challenges with linking food donors to recipients and ensuring product quality persist, online apps are a promising opportunity for the country.

United States: There is an ever-growing number of online apps aimed at resolving the disconnection between potential food donors and those in need, but there are still some notable challenges. An examination of multiple, free, food-donation apps found significant discrepancies in quality and features offered, resulting in untapped potential. Furthermore, most applications seemed to only cover regional areas, adding to the fractured and inconsistent nature of donating food online by app, and posing a usage hurdle for larger companies that operate nationally (Capulong 2016). Another issue that was found is inadequate updating of apps, which resulted in bugs and crashes. The analysis highlighted the challenges of the costs and logistics of producing and improving features of free apps and widening the coverage provided by them, along with meeting maintenance costs. Additionally, the large number of regional applications makes it difficult for organizations to easily identify the best application for their operations (particularly national companies).

A summary of key considerations for implementing the approach of online rescue platforms is presented in TABLE 28.

TABLE 28. Key Considerations for Implementing Approach 5: Online Food-Rescue Platforms

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Low**	For ICI stakeholders with surplus food to donate and recipients, the cost is low, as technology companies have incurred the development costs for these platforms.
Savings (financial savings as a result)	**Medium**	Most of the platforms use tax credits as their primary incentive, so donors can recover costs for their surplus food and save on disposal fees.
Time to Implement (length of time needed to operationalize change)	**Medium**	Scale and geographic coverage will take time to develop, but some cities already have current platforms that work well.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	Food donors and recipients are interested in online platforms. Technology adoption outside the existing food bank model may be slow in some sectors.

4.4.5.4 Example Initiatives

Canada:

- Mesh Food Exchange (British Columbia) is a food rescue marketplace that reroutes unsold or overstocked food to alternative markets. It aims to be a closed-loop system, by increasing access to new markets, improving traceability, and acting as a matchmaking service for farmers, manufacturers, grocery chains, liquidators and distributors, charities and compost companies. Mesh Food Exchange does this through an online platform that connects donors to users, with the option of tailoring to a particular audience (Interview C48).
- Moisson Montréal (Quebec) launched the Food Exchange online platform in 2013, to streamline the food donation process for donors by providing easy access to food donation locations and procedures. In addition, the online platform allows donors to see their donation history, track individual donations and access material for corporate social responsibility purposes (Food Banks of Quebec 2015).

Mexico:

- Software developed by the CIAD and ITESM aims to streamline the logistical operations of the food banks located in Guadalajara, Jalisco (Interview M70). This will reduce costs for food banks and enable them to achieve higher impact.

United States:

- Food Cowboy is a smartphone app that directly connects generators of excess and unwanted food at grocers and restaurants with food rescue operations, via alerts (Interview U32). This initiative is discussed in more detail in Case Study 16.

- Copia (California) is a donation-matching platform that uses a sharing economy model to provide drivers who use their own vehicles to pick up and deliver food; it also provides automated matching and reporting (Interview U31).
- Food Donation Connection (Tennessee) is a well-established platform that connects donors to recipients through a national network that facilitates Web, phone and in-person connections (Food Donation Connection n.d.).
- Cerplus (California) is an online marketplace that works with growers and farms to reduce their losses by selling surplus (second-grade or excess) to buyers at reduced prices (Cerplus n.d.).
- Spoiler Alert (Massachusetts) is a donation matcher, but also a secondary marketplace for food. Spoiler Alert also offers a reporting service, so that donations are tracked for tax incentives (Spoiler Alert n.d.).
- Crop Mobster (California) is an online community exchange platform and social alert service for broadcasting food and agricultural needs and offers, where members publish and respond to alerts for deals, events, donations, and gleaning (Crop Mobster n.d.).
- Waste No Food (California) is a Web-based (online, and app-based) marketplace for donation of excess food from restaurants, cafeterias, hotels and grocery stores, through which vetted anti-hunger organizations can claim food and must use their own transportation to get it (Waste No Food n.d.).
- Feeding America (Illinois) received a US$1.6 million grant from Google charitable division to provide its food banks and related organizations with an online program that allows ICI stakeholders to quickly and efficiently document food donations via an "Online Marketplace" (ReFED 2016).

4.4.6 Approach 6: Feeding Animals

4.4.6.1 Description

Surplus food and food no longer fit for human consumption (e.g., food-processing byproducts) can be recovered for feeding animals. This food can then be minimally processed (e.g., dehydrated) and mixed into dry animal feed for livestock. The ratio of surplus food to other content in the feed changes with the consistency, amount and type of surplus food and the animals involved. Industrial processes such as rendering, heat-treatment or palletization can be used to blend or process surplus food into animal feed products, such as pet food and fish food pellets. Surplus food can also be fed directly to animals without processing, although this practice is done informally—for example, to feed domestic animals in a residential setting, or on smaller farms in rural areas.

The types of surplus food that can be used for animal feed come from the following sources (Ferguson 2016, 236):

- Farms: surplus or off-grade fruits, vegetables, and grains
- Food processors: pomace and pulp from juice and sauce production; high-fiber residues from flour, starch, and nut production; high protein meals from oil production; residues from the brewing and distilling industries; animal renderings from meat production; fish scales and inedible parts from the fisheries industry
- Food distributors and retailers: fresh and processed fruits and vegetables; manufactured foods rejected for quality, aesthetics, or overproduction
- Foodservice: pre-consumer food preparation waste (e.g., peels, skins, trim fat, bone); plate waste; and spoiled food

4.4.6.2 Trends

In Canada and the United States, there is a well-established system and infrastructure for farms, processors, and rendering facilities to use surplus food for animal feed (MacRae et al. 2016; BSR 2014; Interviews C7, C12). In Mexico, this system is not well utilized, with the exception of meat slaughterhouses and facilities that produce meat or bone meal for incorporation into animal feeds, such as poultry feed (Interview M26).

The primary reason farmers and food processors send surplus food to animal feed processors is economic, as it avoids disposal cost. Farmers generally send surplus food to animal feed processors without receiving payment (Interview C7). Since the type of surplus food from farms and food processors is more uniform compared to that found in retail and foodservice, low in contamination, and generated in fairly large quantities at a few collection points, it is ideal for animal feed (Ferguson 2016, 260). Due to its consistency, uniformity and relatively large quantity produced at each source, surplus food from farms and processors also has a known and reliable nutrient content (mostly energy and fiber), which is an important factor for animal feed (Ferguson 2016, 260; BSR 2014, 11).

However, one downside of sending surplus food to animal feed processors is that the cost of dehydration can be high. Fruit, vegetable, and grain products typically require minimal processing for animal feed. Since animal feed still needs to be treated as food rather than as waste, in order to prevent pathogens and contamination, typically the feedstock needs to be dehydrated to maintain nutritional quantity and increase storage life (Interview U24). New technologies are in development to reduce the cost and resource intensity of this process, which may make it more viable in the future (Interview U27). Proteins, oils, fats, meats, and bone, on the other hand, require rendering so that they can be processed into a feed product. Food rendering is the conversion of waste products of animal butchery into animal feed, bone meal, tallow, oil and fertilizer (Medical Dictionary for the Health Professions and Nursing 2012). Rendering is the most popular type of processing currently (Interview C12). The National Renderers Association represents 95 percent of United States and Canadian production, processing over 27 million tonnes of discarded animal material and one million tonnes of unused meat and poultry annually (National Renderers Association 2017).

The use of retail or plate waste for animal feed processing is not as common because it has higher variability (BSR 2014, 9). Due to the variability in the food types, surplus food from retailers and foodservice is less compatible with animal nutrition needs (BSR 2014, 9). When food recovery from these sectors occurs for animal feed, it is usually as a result of informal arrangements between the source and recipient.

Although use of surplus food from the retail and foodservice sectors is not as common for livestock, there are some emerging technologies for animal feed that are planning to use or are already using insects in processing surplus food that contains primarily fruits, vegetables, and grains from the retail and foodservice sectors (Toller 2015; Ostroff 2016).

Specific trends in each country are highlighted below.

Canada: Under the Feeds Act and Regulations, many kinds of plant, fish and animal processing byproducts are permitted to be used for animal feed (MacRae et al. 2016). The Canadian feed industry uses a large share of Canada’s available grain supply (excluding exports), accounting for 80 percent of barley, 60 percent of maize, and 30 percent of wheat produced (ANAC 2012). By using recovered food as an alternative source of animal feed, there is the dual benefit of decreasing the reliance on food grown for fodder and of diversion of surplus food. For livestock, poultry and fish farmers, animal feed is the largest input cost and can be up to 75 percent of the total cost of operations (ANAC 2012; Fisheries and Oceans Canada 2012). There is an opportunity to offset the cost of purchasing feed by using recovered food or food-processing byproducts. Currently, there are 73 rendering and meat processing facilities listed on the Government of Canada’s website (Government of Canada 2016a).

The Canadian aquaculture feed sector is a global leader in the replacement of fish meal and fish oil with alternative feed sources, and the sector is researching the further development of alternative feeds from animal, vegetable, microbial and algal sources. According to a 2012 Report on Aquaculture Sustainability in Canada, seven companies operated nine aquaculture feed mills in the provinces of British Columbia, Ontario, New Brunswick and Nova Scotia, with a total annual production estimate of 150,000 to 200,000 tonnes (Fisheries and Oceans Canada 2012).

Mexico: According to the National Council of Producers of Balanced Food and Animal Nutrition (*Consejo Nacional de Fabricantes de Alimentos Balanceados y de la Nutrición Animal*—Conafab), 61 percent of animal feed comes from virgin feed grains (Pedroza Martínez 2016). Much of these virgin feedstocks could be displaced by recovered food if supply chains were formally established to link sources of surplus and wasted food with animal feed producers (Interview M57). Currently, 22 percent of animal feed material comes from recovered food byproducts (Pedroza Martínez 2016).

Processing of meat and meat byproducts into animal feed is a well-developed industry in Mexico. Currently, 98 facilities in the country manufacture products such as blood meal and meat meal (Senasica 2016, Interview M19). In addition, some of these facilities also render fat for pet food processing. This form of processing is also expanding to the fisheries industry (Senasica 2016; Interview M74).

There is great potential for expanding the use of wasted fruits and vegetables in animal feed manufacturing (Romero 2013). For example, one of the pet food associations indicated interest in opportunities to work with sectors that can provide surplus food and byproducts such as citrus peels, cane chaff, byproducts from beer processing, cookies, bread and coconut (Interview M57).

Outside of the formal animal feed production sector, surplus food from different sectors such as supermarkets, local markets, and foodservice establishments, and directly from the field, are used to feed domestic and farm animals. Agricultural and agro-industrial activities give rise to a large volume of crop residues and byproducts that can be used as feed for animals. Examples include residual materials from crops such as corn, wheat, beans, rice, barley, soybeans and cotton, as well as byproducts of the sugar industry, such as molasses, sugarcane tops and bagasse (Sagarpa n.d.).

United States: A recent study by the Food Waste Reduction Alliance (FWRA), based on surveys with food manufacturers, suggests that 95 percent of the 19 million tonnes of surplus food generated annually from the food manufacturing industry is recycled, and most of that goes into animal feed (BSR 2014, 9). Research at the national level indicates that 26 percent of animal feed consists of food-processing byproducts (USDA 2012). There are approximately 100 rendering plants in the United States (National Renderers Association 2017).

4.4.6.3 Challenges and Special Considerations

Although food waste products are generated as byproducts of human food production, the product must have a nutritional value to be considered a feed. The variable content and sources of surplus food can cause significant variation in nutrient content, which limits the extent of its inclusion in animal diets (Ferguson 2016, 258). Furthermore, to preserve nutrients, surplus food from manufacturers and retail/restaurants may require additional processing prior to animal consumption; the most common requirement is the removal of moisture content (Interview U24). This type of processing raises costs. If moisture is retained, it increases transportation and handling costs and can increase the spoilage rate. If there is spoilage or contamination with mold or bacteria in the surplus food, then it can render it unsuitable or dangerous to animals (Ferguson 2016, 258). Animals raised on inferior feed can develop health issues.

Besides the regulatory and food safety challenge to using plate waste for animal feed, the variability of the feedstock also presents a challenge (Ferguson 2016, 258–259). Since animal feed needs to meet the different nutritional requirements of the species, it is more difficult to determine the nutrient content of a mixed feedstock from plate waste compared to a single stream from a farm or processor.

Another challenge more relevant to animal feed processors is the siting or expansion of facilities. Due to the odor impacts (McGillvray 2016), siting rendering facilities close to surplus-food generators is more challenging.

Lastly, there is an economic challenge if the distance between the source and receiver are too far to make transporting the feedstock worthwhile. The combined factors of low costs for landfill disposal and the fees for processing and transportation can make food recovery for animal feed uneconomical in some circumstances.

Specific challenges and considerations in each country are highlighted below.

Canada: Under the Feeds Act and Regulations, all ingredients to be used as animal feed must be approved and listed in the Feed Regulations. Mixed food wastes from various sources—restaurants, institutions and food processing facilities—have been registered; however, those that are in research and development mode cannot be used until approved.

Mexico: There is no formal system to connect generators of surplus food with animal feed processors. In some cases, processing companies go door-to-door to obtain feedstock, which requires considerable resource investment (Interview M56). In other cases, restaurants or food manufacturers donate food to local farms to be used as animal feed (Interviews M11, M68), fish waste is collected and processed to produce fish meal (see Case Study 18), and market waste-pickers reroute food for recovery from the market disposal area (see Case Study 19). Despite these initiatives, some supermarkets remain concerned that donating surplus food or food no longer fit for human consumption may present a reputational risk, if animals fed the surplus food develop health problems arising from inadequate handling practices or other negligence (Interview M58).

Additionally, based on interviews with market-stand owners in Mexico City, equipping the stand owners with a myriad of supplies and practices presents challenges when collecting surplus food for animal feed (Interviews M67, M71, M72). Different types of food have varying safe storage and handling requirements for temperature, moisture and method of handling. Market-stand owners rarely have the resources to separate the food or offer storage conditions (fridges and freezers) specific to food type, nor do they have operational funding for electricity, and security personnel to monitor the storage area. Some surplus products—such as waste from fish processing—are utilized as inputs for animal feed, as shown in Case Studies 18 and 19 for *La Nueva Viga* Fish Market and Medellín Market, respectively. In less dense areas, markets often span considerable distance, making it difficult to centralize processing facilities to take advantage of economies of scale.

Although there is interest from zoos in using surplus food for animal feed, there are also many challenges. Zoos have strict quality standards for the food they receive, to ensure the animal feed has the correct nutritional balance and to avoid potential disease (Interview M17). Animal protection associations and veterinarians have warned against feeding surplus food to animals, since it can be damaging to their digestive tract (El Informador 2013). Since the supply of surplus food is unpredictable as to quantity, type, and timing, most zoos cannot rely on surplus food for animal feed. Private zoos were more open to exploring the opportunity to buy surplus food for animal feed, but this practice has generally ceased, due to lack of transportation and to the low quality of the produced animal feeds (Interview M55). Another challenge for zoos is the political risk. Public opinion and bad publicity about the government's feeding its animals "leftovers" could create major problems for zoos, so this approach should be considered with caution (Interview M29).

United States: From a food safety perspective, the federal Swine Health Protection Act has specific requirements concerning feeding surplus food to pigs, primarily because pig farmers lack the necessary equipment to comply with the requirements (Ferguson 2016, 259). Surplus food from restaurants and cafeterias must be heated to 100 degrees Celsius for 30 minutes before it can be fed to swine (Ferguson 2016, 259). Only about 2,500 swine facilities are licensed to handle surplus food for swine feeds, which is equivalent to less than 1 percent of all swine facilities (Ferguson 2016, 259). While the federal law permits feeding food scraps to animals, many states further restrict using surplus food to feed animals, which adds another regulatory challenge to overcome (Leib et al. 2016, 57).

A summary of key considerations for implementing the approach of feeding animals is presented in TABLE 29.

TABLE 29. Key Considerations for Implementing Approach 6: Feeding Animals

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium to High**	Initial processing (e.g., de-packaging, dehydration and/or heat treatment) and transportation of surplus food for generators or animal feed manufacturers (depending on who pays for these services) can be costly, especially for surplus food with high moisture content. If an ICI stakeholder were to set up a new process for converting surplus food to animal feed, there are higher costs to procure, install, and set up operations.
Savings (financial savings as a result)	**Low to Medium**	For surplus-food generators, there is disposal cost avoided, but current waste management options are inexpensive. Savings would be higher in municipalities where there are higher tipping fees. Similarly, for animal feed manufacturers, the savings of using surplus food instead of virgin materials may be minimal if the surplus food needs to be transported from farther distances.
Time to Implement (length of time needed to operationalize change)	**Short to Medium**	Large amounts of surplus food (although mostly inedible to humans) from farms and processors is already used for animal feed, so implementation in those sectors would be shorter, due to an existing system. For retailers and foodservice in the United States and Canada, and generally in Mexico, it is less common to send surplus food to animal feed, so more time would be needed to set up systems and processes to divert surplus food from these sectors.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium to High**	Overall, there is a high interest in this approach amongst stakeholders throughout the food supply chain, especially animal feed manufacturers. This approach is already widely practiced and where proximity and feedstock allows, there is a high level of participation. However, where a system is not in place (foodservice and retail in the United States, in Canada, and generally in Mexico), there is a lack of infrastructure and connection between source and recipient. In these cases, the generators are more likely to use municipal waste hauling services.

4.4.6.4 Example Initiatives

Canada:

- Enterra (British Columbia) is using pre-consumer surplus food to produce poultry feed and fish feed processed with larvae of the black soldier fly. This initiative is further discussed in Case Study 17.

- West Coast Reduction (British Columbia), Rothsay (Ontario) and Sanimax (Quebec) are examples of well-established rendering facilities that create a variety of animal feed products.

Mexico:

- Grupomar (Manzanillo), *La Nueva Viga* Fish Market (Mexico City) and Productos Piscícolas (Morelia) collect and process fish waste to produce fish meal. This initiative is further discussed in Case Study 18.
- La Posta Restaurant (Mexico City) is donating about 10 kilograms of bread per week to a neighbor, for feeding animals at a small urban farm, and five kilograms per week to an employee for feeding pets (Interview M11).
- Market Melchor Ocampo (Mexico City), a large market in Mexico City, has "pepenadores," or waste pickers, who reroute food from the market disposal area every two days, for recovery. As an example, this effort is responsible for the diversion of an estimated 30 tonnes of chicken byproducts to animal feed. This initiative is further discussed in Case Study 19.
- Bimbo, the largest bread manufacturer in Mexico, sends day-old bread from grocery stores and mobile bread vendors to feed farm animals (Interview M68).
- Walmart is negotiating the sale of surplus food (mainly bread from their bakeries) to farmers (Interview M58).

United States:

- Desmet Ballestra Group supplies equipment for processing raw materials into animal feed. The group utilizes methods such as grinding, dosing, pelletizing, mixing, thermal treatment, dedusting and cleaning (Desmet Ballestra 2013).
- Walmart diverted 60 percent of organic waste to animal feed in 2014 (Worley 2014).
- Sandwich Me In (Illinois) sends food scraps to local chicken farms and then uses the eggs from the chickens to cook for customers (ReFED 2016, 65).
- Foodland Super Market (Hawaii) diverts 450 tonnes of meat and seafood from 19 Oahu stores, for agricultural feed, and 300 tonnes of produce scraps from 14 stores, for pig feed, on an annual basis.

4.4.7 Other Identified Food Rescue and Recovery Approaches

The last two approaches identified for food rescue and recovery—Creating Public Private Partnerships for Donations, and Standardizing Donation Regulations for Food Safety—could be beneficial in addressing food rescue and recovery and causes of FLW across the food supply chain, as introduced in Section 2.3. However, these approaches are not discussed in detail in this report because they are not frequently mentioned in the literature reviewed and not referenced by surveyed key stakeholders.

4.5 Policy and Education/Awareness Program Opportunities

There are opportunities for policies and education/awareness programs to support and expand food rescue and recovery. This section presents examples of promising policies and programs that have been implemented globally, regionally in North America and in each of the three countries.

4.5.1 International

Most of the global initiatives for reduction of FLW presented in Section 3.5.1 also apply to food rescue and recovery. Examples of these global initiatives include the UN's Sustainable Development Goal 12.3, the FAO's Save Food initiative and the UK's Waste and Resources Action Programme.[6] The goals, targets and education campaigns are generally aimed at increasing awareness of food waste and promoting the reduction of food waste. The differentiation between FLW reduction and food rescue and recovery starts to blur in some of these cases, as food rescue and recovery contributes to reduction of FLW in disposal or other forms of processing, which is often the key message of global educational campaigns.

One example of a national-level policy outside of North America is France's ban on disposal of food by large ICI stakeholders, and the requirements that they donate surplus to charity (Chrisafis 2016). This law came into effect on 11 February 2016. Retailers had until 11 February 2017 to engage in contracts with food rescue organizations or food banks. This law was received with optimism, as a way to reduce food waste, but it was also met with concern that food charities would be forced to accept food that is unsuitable for consumption or be overwhelmed with donations of food that are not needed or cannot be financially managed by the charities because of their limited resources (Interview I1).

4.5.2 Regional

At the North American Leaders Summit in June 2016, food rescue and recovery was included as part of the North American Climate, Clean Energy, and Environment Partnership Action Plan. Specifically, the Action Plan stated that the three governments will "Support the regional commitment and collaboration initiative under the Commission for Environmental Cooperation using voluntary measures to reduce, rescue and recover food waste in North America, in line with Target 12.3 of the UN Sustainable Development Goals, which envisions a 50% reduction in global food waste by 2030" (Government of Canada 2016d).

The three North American countries are currently collaborating on food waste through the Commission for Environmental Cooperation, which has food rescue and recovery as one of its focus areas. Although there are no specific policies or programs in place concerning food rescue and recovery across North America, there are opportunities for the three countries to collaborate to adopt initiatives, as outlined in Section 4.5.1.

One opportunity for North American collaboration is cooperation around border crossings, to increase the efficiency of food commodity imports and exports. An initial step toward creating these regional networks for food rescue and food recovery is to estimate the amount of food crossing borders, the time required to cross, and the percentage of food that cannot cross and must be rerouted or disposed of at the border.

4.5.3 Canada

As mentioned in Section 3.5.3, there are some national-level initiatives on reduction of FLW. These initiatives also span into food rescue and recovery.

On a provincial level, the British Columbia Centre for Disease Control (BCCDC) collaborated with ICI stakeholders and regional governments to develop comprehensive food donation guidelines. These guidelines were developed as a response to confusion from donors and food distribution organizations

[6] See Section 3.5.1 for further information about these programs.

(FDOs), such as food banks, on how to handle and manage recovered food in a way that would meet food safety standards. The Centre published two sets of guidelines in 2015. The *Guidelines for Food Distribution Organizations (FDOs) with Grocery or Meal Programs* clarifies issues with liability for FDOs, provides tips on developing relationships with volunteers and other FDOs, and gives guidance on nutritious and safe foods that are suitable for donations. The document also includes guidelines on how to evaluate the suitability of donated foods for human consumption. The *Industry Food Donation Guidelines* helps ICI stakeholders start and manage a food donation program and evaluate which types of foods are suitable for donations, and it addresses concerns about liability issues (BCCDC 2015).

4.5.4 Mexico

As mentioned in Section 3.5.4, the National Crusade Against Hunger includes an objective to minimize food waste and losses in the storage, transportation, and distribution of food in the sector of central supply markets and retail. One of the focus areas of this objective is recovery of edible food along the food supply chain in order to contribute to hunger reduction (DOF 2013).

The Thematic Network on Food Security (*Red Temática de Seguridad Alimentaria*), currently funded by the National Council of Science and Technology (*Consejo Nacional de Ciencia y Tecnología*—Conacyt), that focuses on agriculture and industrial waste valorization and decrease of food waste and losses, has organized two forums on food waste. The Thematic Network on Food Security comprises researchers from different universities and institutions across Mexico who convene to focus on food rescue and recovery efforts. The goal of these forums is to increase awareness and disseminate information to interested parties.

At a local level, Mexico City’s Legislative Assembly passed the Altruistic Food Donation Law by unanimous decision (Gaceta Oficial de la Ciudad de México 2017). The objective of the law is to promote, guide and regulate donations of food suitable for human consumption and to avoid food waste.

4.5.5 United States

In the United States, most of the attention on food rescue has been on donating food for hunger relief. As mentioned in Section 3.5.5, the USDA and EPA launched the Food Waste Challenge, which calls on organizations and leaders across the food chain to voluntarily commit to food waste reduction, and recovery and recycling of food. To encourage food donation and gleaning, the Food Waste Challenge developed toolkits and campaigns such as *Feed Families, Not Landfills* and *Let’s Glean, United We Serve*. The Food Waste Challenge’s website also includes resources such as relevant laws on food donations and lists of organizations working on food rescue that people could connect with.

Local governments have also developed education and awareness campaigns. For example, the Waste Not OC Coalition (Orange County, California) is a public-private partnership working on food rescue, food distribution, and training and education to end hunger in Orange County (Waste Not OC Coalition n.d.).

5 Measuring, Tracking and Reporting

Measuring, tracking and reporting are tools to more effectively inform actions to meet goals for reduction of food loss and waste (FLW), and for food rescue and recovery. This section identifies key approaches in Canada, Mexico and the United States.

Measuring, tracking and reporting are defined as follows:

Measuring is the quantification of FLW and involves determining the amount of FLW by using an instrument or device marked in standard units or by comparing a mass of FLW with an object of a known amount (WRI 2016).

Tracking and analytics provide users with ongoing data regarding waste quantities and wasteful practices, in order to inform behavior and operational changes (ReFED 2016). Tracking is the act of recording continuous and consistent detailed information while comparing results against a baseline or targets (WRI 2016). Tracking enables establishment of baselines; visualizations of trends; diagnosis of issues, to identify reasons why food is wasted; and enhanced awareness of the amount of FLW (LeanPath n.d.a.).

Reporting shares results from measurement and tracking, increases accountability, and supports engagement with internal and external stakeholders, including those responsible for setting the FLW reduction goals (WRI 2016).

5.1 Building the Case for Measuring, Tracking, and Reporting Food Loss and Waste

According to *Food Loss and Waste Accounting and Reporting Standard*, countries, companies and entities around the world currently lack sufficient information about FLW (WRI 2016).

Quantifying and characterizing FLW data through measurement, tracking and reporting are necessary steps to understanding how much, where and why FLW occurs in the overall food system and along specific food supply chains (EC 2016). Taking these steps will support collecting data that is comparable, identify targeted solutions, prioritize actions, and show FLW reduction improvement over time (WRI 2016).

This section provides an overview of benefits of FLW measurement, tracking and reporting, for different stakeholders.

5.1.1 Industrial, Commercial and Institutional

Data collected by the ICI sector helps identify the quantities and types of FLW, identify trends in food preparation and operation efficiencies to reduce FLW, and build the business case for investment in FLW prevention and reduction solutions (ReFED 2016, 32). Efficient tracking of FLW data can avoid spoilage, cross-contamination and overstocking of products, and can reduce costs, increase profits, and help the business become more competitive through taking effective actions to reduce waste (Gooch, Felfel and Glasbey 2014, 8). In the United States alone, the 2016 Rethink Food Waste through Economics and Data (ReFED) report estimated that restaurants and foodservice facilities have the opportunity to save US$1.3 billion annually through tracking and analyzing their FLW (ReFED 2016, 32). These projected savings could apply in a similar context in Canada and Mexico, but the anticipated costs and benefits may vary.

Aggregation and analysis of data from multiple sources within the ICI sector can be a powerful tool to uncover new insights and better understand the problem with FLW within the sector. Measurement and tracking allows the development of a baseline for the ICI sector, as well as sub-sectors. This aggregation of data creates opportunities for individual entities to compare themselves with others or the sector average, and can help with setting targets and performance metrics. From ICI-sector interviews, tracking was identified as being the approach that has the greatest potential to reduce waste overall (Interviews C9, C15, C24, C26, C41, M21, M81, M82, U6, U13, U28).

Besides enabling cost savings, tracking and reporting of FLW can improve employee performance, especially for those involved in the progress of the tracking and reporting. Tracking activities engage members and provide transparency and awareness, which allows everyone to take ownership and be involved with achieving waste reduction goals (Interview M82; LeanPath n.d.a). Regular reporting of FLW and prevention can help make preventing FLW a socially expected practice, similar to recycling in a workplace. Examples of approaches and initiatives for measuring, tracking and reporting FLW are discussed in Section 5.4, below.

5.1.2 Government

As awareness of FLW continues to build, so will the need for more data to measure and track progress toward achieving FLW prevention and reduction goals. Acquiring these data will require funding and investment in technology and software for measuring, tracking and reporting. Accuracy (particularly in public reporting) increases accountability toward meeting FLW reduction commitments or requirements for governments (EC 2016). These data provide policy makers with valuable information for shaping public policies well-tailored to tackling the issue and prioritizing necessary actions along the different parts of the food supply chain (EC 2016). Furthermore, FLW data can be linked to other environmental or socio-economic indicators—for instance, as a useful way to track progress toward such environmental objectives as reducing water use, or avoiding, through FLW reduction, recovery and diversion, methane emissions produced from food decomposing in landfills.

5.1.3 Nongovernmental Organizations

FLW data can support NGOs working in advocacy efforts on FLW issues, as well as support them in securing funding and resources. NGOs can demonstrate the scale of the FLW problem and educate the public and potential funders by using the compelling evidence of data. It is also important for NGOs to track and report the FLW involved in interventions they undertake, so that they can evaluate the effectiveness of the solutions they tried in addressing the FLW problem; and this is often a requirement of funders, to justify how resources were used.

For NGOs working in food rescue situations where tax deductions or credits for donations exist, NGOs capable of tracking donations are better positioned to attract donors that require tax receipts. NGOs can also use tracking data to identify inefficiencies in supply management and handling. For example, NGOs can identify foods that tend to spoil before they are used, or specific foods (e.g., bread) received in large quantities that end up being disposed of. NGOs can then target donor recruitment efforts, as well as give feedback to donors on what they need.

5.2 Challenges to Measuring, Tracking and Reporting of Food Loss and Waste

Organizations have different purposes and goals for quantification, which influence their definitions of FLW (WRI 2016). The different definitions and interpretations of FLW (e.g., food waste, wasted food, surplus food, edible food and inedible food) affect the methodologies and scope for measurement, tracking, and reporting (WRI 2016).

The variation in definitions and methodologies makes it difficult to collect statistics, compare and analyze data over time, and provide the appropriate recommendations (WRI 2016). None of the three

North American countries has a standard for measuring, tracking and reporting FLW (Abdulla et al. 2013, 139; ReFED 2016) and thus, significant variabilities exist across all levels of measurement, tracking and reporting of FLW (Interviews C42, C43, M21, M81, U11, U12, U18, U34). Differences that must be reconciled include:

- terminology to describe the stages of the food supply chain;
- the geographic scope and sectors included in the food system;
- food categories included in the analysis; and
- units of measurement (such as kilograms per capita versus dollar value) (WRI 2016, 47).

Challenges in measuring, tracking and reporting FLW along the food supply chain are summarized in TABLE 30.

TABLE 30. Challenges to Measuring, Tracking and Reporting Food Loss and Waste in North America

Supply Chain Stage	Challenges in Measuring, Tracking and Reporting Food Loss and Waste
Food Production Post-Harvest	- Unharvested products are not recorded - Lack of resources and staff time for measuring FLW
Processing	- Concern for disclosing market information to competitors through FLW reporting - Lack of resources to shift from financial metrics to weight-based tracking - Current inventory management systems appear adequate
Distribution	- Lack of resources for measuring tools, such as truck scales - Measurement tools not prevalent in sector
Retail	- Concern for disclosing market information to competitors through FLW reporting - Current inventory management systems appear adequate - Lack of resources and staff time for measuring FLW
Foodservice	- Perceived low return on investment - Lack of resources and staff time for measuring FLW - Current inventory management systems appear adequate
Rescue (NGOs)	- Lack of resources and staff time for measuring FLW - Concern for disclosing market information to competitors through FLW reporting
Government	- Lack of standard methodology among varying levels of government and jurisdiction - Lack of regulatory requirements for measuring, tracking and reporting - Lack of interdepartmental coordination - Lack of funding for overseeing tracking and reporting of FLW

5.3 Methods for Measuring, Tracking and Reporting Food Loss and Waste

Table 31 outlines a variety of methods commonly used to quantify FLW according to the FLW Accounting and Reporting Standard (FLW Standard). The approaches apply to all stages of the food supply chain. The approaches below measure FLW with a variety of metrics. FLW measurement results are often expressed in unit count or unit volume of food product items, which is then converted into weight. FLW values can also reflect other terms or units of measurement, such as environmental impacts (e.g., energy use, greenhouse gas [GHG] emissions, water use and land use), nutritional content (e.g., calories, nutritional value) and financial implications (e.g., price of labor, value of lost revenue, price of ingredients purchased) (WRI 2016). Normalization of metrics is important, in order to allow for comparability (Interview U6).

Although some of the methods provided in TABLE 31 are standalone methods, most are components of a broader approach (e.g., direct weighing is used in waste composition analysis). Four approaches commonly used by stakeholders across the food supply chain for measuring, tracking and reporting are described in Section 5.4.

TABLE 31. Methods of Quantifying Food Loss and Waste

Category	Method	Definition
Measurement or Approximation Requires direct access to FLW	Direct Weighing	Using a measuring device to determine the weight of FLW.
	Counting	Assessing the number of items that make up FLW and using the result to determine the weight; includes using scanner data and "visual scales."
	Assessing Volume	Assessing the physical space occupied by FLW and using the result to determine the weight.
	Waste Composition Analysis	Physically sorting FLW from other material to determine weight and composition; includes direct weighing, counting, or assessing volume, to obtain metrics to calculate or infer composition.
	Records	Using routinely recorded data that are collected for reasons other than quantifying FLW (e.g., waste-water transfer receipts, or warehouse record books). Records may be used as proxy data or integrated as part of survey data.
	Diaries	Maintaining a daily record or log of FLW and other information (e.g., paper or electronic diary kept in kitchen). This approach includes direct weighing, counting, or assessing volume, to obtain data for daily logs.
	Surveys	Gathering data on FLW quantities, or gathering other information (e.g., attitudes, beliefs, self-reported behaviors), from a large number of individuals or entities, through a set of structured questions.
Measurement or Approximation Requires direct access to FLW	Mass Balance	Measuring inputs (e.g., ingredients at a factory site, grain going into a silo) and outputs (e.g., products made, grain shipped to market), alongside changes in levels of stock and changes to the weight of food during processing. This is considered to be one type of model (see below).
	Modeling	Using a mathematical approach based on the understood interaction of multiple factors and processes that influence the generation of FLW.
	Proxy Data	Using FLW data that are outside the scope of an entity's FLW inventory (e.g., older data, FLW data from another country or company) to infer quantities of FLW within the scope of the entity's inventory. Proxy data are generally used as part of a modeling exercise or may be requested in surveys.

Source: WRI 2016.

5.4 Current Approaches to Measuring, Tracking and Reporting Food Loss and Waste

The following subsections describe four approaches to measuring, tracking and reporting FLW:

- **Waste Composition Analysis:** Direct weighing, counting, and assessing volume are methods used to conduct a compositional analysis.
- **Diaries:** Data resulting from direct weighing, counting and/or assessing volume are recorded in a diary format.
- **Surveys:** Requests for records and proxy data are included as part of data collection.
- **Models and Proxy Data Extrapolation:** Records, mass balance models, proxy data, as well as any primary data collected (waste composition analysis, diaries, surveys) are used to inform modeling and extrapolation.

The subsection for each approach includes a general description, current trends in applying the approach, challenges, implementation considerations, and examples of initiatives. Notes specific to each country are also included. Case studies for each of the approaches are described in Section 9.

This section also includes international uses of these approaches, so as to highlight some best practices and the challenges of using FLW data on global and country-specific scales.

Key considerations for implementation were grouped into four categories, as follows:

- Costs: Additional costs needed for implementation (capital and operating)
- Savings: Financial savings as a result of implementing this approach (capital and operating)
- Time to implement: Length of time needed to operationalize change
- Anticipated level of stakeholder support: The level of buy-in that stakeholders will have for this approach

The potential of each of the considerations was rated, using the scales presented in TABLE 32.

TABLE 32. Ratings Applied to Key Considerations for Measuring, Tracking and Reporting

Key Consideration	Rating Scale
Costs	Low = low annual cost Medium = medium annual cost High = high annual cost
Savings	High = high cost savings Medium = medium cost savings Low = low cost savings
Time to implement	Short = implementable in the short term Medium = implementable in the medium term Long = implementable in the long term
Anticipated level of stakeholder support	Low = low support by stakeholders Medium = medium support by stakeholders High = high support by stakeholders

5.4.1 Approach 1: Waste Composition Analysis

5.4.1.1 Description

Waste composition analysis is a useful tool for determining the types and quantities of food in waste streams and identifying opportunities for improvement. Waste composition information can be used to measure a diversion rate, set goals and create a standard monitoring process (ReFED 2016, 81).

Quantification of FLW in the waste stream at state and local-government levels typically takes the form of waste composition analysis. These waste composition analyses involve primary measurement and sorting of waste into material categories, from basic categories (e.g., food, non-food, recyclables, and residuals) to detailed categories (e.g., differentiating between types of edible food and of inedible food) (Interviews C43, U41). The composition of the waste is reported as percent by weight, although in some cases the composition is recorded by volume or by item count.

5.4.1.2 Trends

In all three countries, waste composition analyses generally separate FLW from other materials. When FLW is separated, it is typically considered as falling into one category and is not further split into sub-categories (Interview U41). In the past few years, due to the growing interest in the types of food in waste, a number of municipalities and non-profit organizations, especially those in Canada and the United States, have designed waste composition analyses to further disaggregate data on FLW (Interviews C43, U34). These studies may include separating edible versus inedible food, identifying rescuable food, separating by food type (e.g., dairy versus meat) or sorting into detailed food categories (e.g., apples versus bananas). Generally, larger or more environmentally progressive municipalities and organizations undertake waste composition analyses that are more detailed.

Specific trends in each country are highlighted below.

Canada: Many municipalities have conducted waste composition studies that included organic waste as a category but typically do not measure FLW separately from other organic waste, such as yard trimmings (Interview C43). A national database of waste characterization studies is not available, therefore it is not possible to quantify how many municipalities have conducted waste composition analyses and to what degree of detail. A recent report by the National Zero Waste Council identified FLW composition data in Ontario, Alberta, Manitoba and British Columbia (NZWC 2017).

Mexico: A number of waste composition analyses have been conducted in Mexico on municipal solid waste, which quantified either FLW or organic waste. These studies were typically conducted in a single city or urban region. Cities that have conducted waste composition analyses include Guadalajara, Chihuahua, Ensenada, Mexico City and Morelia (Bernache-Pérez et al. 2001; Gómez et al. 2009; Aguilar-Virgen et al. 2013; Duran Moreno et al. 2013; Buenrostro et al. 2001). No studies that further disaggregated FLW into more-detailed categories were encountered in the literature review. Waste composition analyses in various states were also conducted, as part of the development process for the Mexico Landfill Gas Model—and as part of the Mexico Low Emissions Development (MLED) program in 2013 (Stage and Davila 2009; Romero 2013). Available waste-composition data are presented in Appendix 4.1.

United States: Nongovernmental organizations, including the Natural Resources Defense Council (NRDC) and ReFED, have been advocating for more FLW-specific data collection in the United States. Three states have conducted waste composition analyses that sort food into general categories (e.g., packaged versus unpackaged, or backyard compostable versus non–backyard compostable) (CalRecycle n.d.; Connecticut Department of Energy and Environmental Protection 2016; Massachusetts Department of Environmental Protection n.d.). Most of these food-waste-specific studies were focused on the residential sector, although the states of California and Connecticut, in the programs referenced just above, included the ICI sector. NRDC conducted waste composition analyses of FLW in the residential and ICI sectors in Nashville, Denver and New York. The NRDC study is the first of its kind in the United States to assess FLW by using detailed categories.

5.4.1.3 Challenges and Special Considerations

Waste is heterogeneous in nature and a large number of samples are required for statistical relevance, which increases the human and financial resources required. A major challenge for municipal public agencies is that they have limited resources or do not prioritize efforts to measure and track FLW data (Interview U40).

Markets with multiple waste collection service providers tend to have difficulty reporting waste quantities. This often correlates with how regulated a market is; free market jurisdictions often have more difficulty measuring waste streams (Interview U41). Without the existence of reporting requirements through contracts or regulation, waste collection service providers may track overall volumes disposed of, but not the composition of the waste stream (BSR 2014, 24).

There are also methodological challenges to waste composition analysis because it only captures the waste collected by haulers. FLW disposed of down the drain, composted on-site or fed to animals is not counted. Furthermore, food material can break down and become contaminated with paper, distorting food weight measurements (ReFED 2016, 7). Similarly, the moisture transfer can distort food weight measurements when wet foods add moisture to drier foods, which increases the relative quantity of the drier food (Kelleher and Robins 2013, 36). Compaction of waste samples from being transported in a truck can also hamper efforts to distinguish between avoidable and unavoidable food waste.

Specific challenges and considerations in each country are highlighted below.

Canada: Waste sent to disposal and recycling is more frequently tracked in the residential sector than in the commercial sector because in the latter it is typically managed by private collectors (Interview C45). The Ontario Waste Management Association's (OWMA) 2015 report *Rethink Organic Waste* identified the lack of and inconsistency in data on organic waste generation and composition as a challenge to addressing organic waste (Ontario Waste Management Association 2015, 13). OWMA reported that organics data were mainly available for the residential sector, that governments face challenges in collecting and managing data for the commercial sector, and that the data that are available are not easy to aggregate (Ontario Waste Management Association 2015, 13). In provinces that measure waste from the ICI sector, only waste taken to public facilities is tracked; there is still a data gap for waste destined for private facilities or exported to the United States.

Mexico: Waste composition analyses are part of state-wide waste initiatives in Mexico, but do not necessarily disaggregate FLW from organic waste. Waste composition analyses are also resource-intensive, so it could be challenging for some state-level governments to conduct them on a regular basis. However, there are existing instruments such as the Program for the Prevention and Integral Management of Waste that play a vital role in waste composition analysis (Semarnat 2016).

United States: Publicly available data on waste composition analyses are available from at least 25 states (US EPA 2016e). The timeframe between studies can range considerably and disaggregating FLW data is still an emerging practice (Interview U41). In California, the time between state-wide characterization studies spanned six years and the 2014 study included one category for food (CalRecycle 2015). Cost would be prohibitive to conducting the amount of sampling to create a national estimate, and atypical sampling circumstances related to seasonal moisture levels can occur. Gauging trends over time can be challenging—especially at a national scale, given population size and the corresponding amount of material generated—unless sampling is designed to account for temporal factors (US EPA 2016c).

A summary of key considerations for implementing the approach of waste composition analyses is presented TABLE 33.

TABLE 33. Key Considerations for Implementing Approach 1: Waste Composition Analyses

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**High**	Waste composition analyses are labor-intensive, and costs rise with scope and level of detail. Studies require sampling and statistical expertise in order to yield representative data; depending on scope, studies must use consistent methodology and a regular interval to consistently track trends and provide comparability.
Savings (financial savings as a result)	**Medium**	Waste-composition data can be used to inform program development and assessment, and result in waste reduction and diversion that lower costs, particularly if disposal fees increase with tipping fees for recycling and composting.
Time to Implement (length of time needed to operationalize change)	**Medium**	Planning effort by the entity commissioning the waste composition analysis requires allocation of budget and coordination for procurement of services (if applicable). Planning should consider population size and demographics, level of detail (materials to be sorted) and temporal scope.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	While most jurisdictions prefer to set a waste composition baseline using their own data, others may want to use the resources for other prioritized initiatives.

5.4.1.4 Example Initiatives

Canada:

- The City of Calgary and the City of Winnipeg conducted waste composition analyses that measured FLW as a general category, for the ICI and residential sectors (NZWC 2017).
- The City of Toronto and the City of Edmonton conducted multi-season waste audits that separated food categories by edibility and food group, for the residential sector (Interview C47, NZWC 2017). Similar studies have also been conducted with one-time sampling, by York Region and the University of Guelph (Interviews C4, C45).
- Metro Vancouver (a regional authority in British Columbia, comprising 22 member municipalities) conducted a detailed FLW composition study (separated food categories by edibility, food group, and type within each food group) using material categories based on the Love Food Hate Waste study in the United Kingdom (Cech 2015). More information can be found in Case Study 20. Since 2014, Metro Vancouver has also conducted annual waste composition analyses for the residential and ICI sectors, with food categories separated according to edibility and food group. Alberta Innovates and the British Columbia Ministry of Environment have also conducted similar studies (NZWC 2017; British Columbia Ministry of Environment 2015).

Mexico:

- The Mexico Landfill Gas Model used waste composition analyses to set default FLW percentages for waste going to landfills (Stage and Davila 2009).

- MLED Program conducted waste composition analyses as part of the management of municipal solid waste, *Gestión Integral de Residuos Sólidos Urbanos de la CEDA* (Romero 2013).
- Guadalajara (Bernache-Pérez et al. 2001), Morelia (Buenrostro et al. 2001) and Ensenada (Aguilar-Virgen et al. 2013) conducted waste composition analyses that named FLW as a category.
- Mexico City (Duran Moreno et al. 2013) and Chihuahua (Gómez et al. 2009) conducted waste composition analyses that named organic waste as a category (but did not differentiate FLW).

United States:

- In 2014, CalRecycle conducted a comprehensive, statewide, generator-based waste study to characterize waste disposal and diversion from 16 commercial generator types (CalRecycle n.d.).
- NRDC used waste composition analyses to characterize FLW from the residential and ICI sectors in Nashville, Denver and New York City (Interview U34).
- The states of Massachusetts and Connecticut conducted state-wide FLW composition studies to inform policies, such as a requirement for large-scale commercial generators to recycle organic material (Connecticut Department of Energy and Environmental Protection 2015) and a commercial organics ban (Massachusetts Department of Environmental Protection n.d.). The latter initiative is further discussed in Case Study 21.

5.4.2 Approach 2: Diaries

5.4.2.1 Description

Diaries are a self-reporting tool to measure FLW as well as understand the types of food and reasons for disposal. The objective of recording FLW in a diary format is to capture both the quantity of FLW and the associated behavior that led to each occurrence of FLW. Diaries provide more information, as they identify exactly where and what types of food are wasted. This approach applies to all stakeholders, and can be customized to varying degrees of sophistication (ReFED 2016, 32), from pen and paper to computer tablets with software tailored for weighing and tracking FLW (e.g., LeanPath system). Diaries are also a useful tool for providing city-wide and national studies (e.g., those conducted by organizations like the Natural Resources Defense Council, and the Waste and Resources Action Programme) with data on the characterization of FLW from the residential sector. Diaries can be used by federal, state and local governments as an approach to FLW measurement.

The type of information captured in diaries includes:

- date and time that FLW occurred;
- type of food that went to waste;
- quantity by weight, volume or count;
- source of FLW (e.g., department, meal, generator);
- destination of FLW (e.g., landfill, compost, drain disposal, donation, fed to animals); and
- reason for disposal.

In addition to providing information on where and why waste is occurring, the act of measuring FLW raises awareness about the issue, and therefore may also influence the behavior of the people who are recording FLW in a diary format.

5.4.2.2 Trends

To date, in the ICI sector, diaries have been relied on less than have been inventory management systems, which capture waste and/or shrink (percentage of products not sold) to some degree, through tracking product counts and/or financial value. These tracking systems do not necessarily provide the same level of information that diaries provide on the reason why food was wasted.

However, recording of FLW in a diary format is becoming increasingly prevalent, especially among large foodservice operations and franchises (e.g., hotel chains, institutional foodservice providers) (Interview U6). With a software system, data are typically recorded and operationalized by staff on a daily basis, as part of a regular job routine (e.g., weighing out and reporting at the end of a shift), so the task is not perceived as additional. Through regular tracking of FLW, operational inefficiencies can be identified, diagnosed and corrected. For larger members of the sector, even small operational improvements can result in significant savings, thanks to economies of scale. Software-based systems for diaries are less commonly used among independently owned small and medium-sized enterprises, due to the higher relative capital cost (Interview U13).

Specific trends in each country are highlighted below.

Canada: For large institutional foodservice providers, tracking FLW in a diary format using a software system is a common practice (Compass Group Canada 2014; Aramark n.d.). Information on using diaries in other parts of the ICI sector is not available.

Mexico: Information on using diaries to track FLW in the ICI sector is not available. However, there has been one documented case of using the diary approach to conduct part of an academic research study: in Mexico City, residents self-reported FLW at home (Jean-Baptiste 2013). Although consumers are not included in the scope of this report, such an approach could have applications for the ICI sector.

United States: Among large-scale institutional and hospitality foodservice companies, which represent approximately 25% of the out-of-home market, FLW tracking in a diary format, using software systems, has moved from only being used by early adopters to becoming the industry norm (Interview U6).

5.4.2.3 Challenges and Special Considerations

Most stakeholders in the ICI sector are prone to underestimating the quantity of FLW generated. In the retail sector in particular, stakeholders believe that their inventory management systems deal with FLW reduction effectively and do not see the need to undertake additional data collection.

There is a perception that FLW diaries are expensive, because of the upfront investment required in technology, software and training. In the case of non-software-based (i.e., paper-and-pen) systems, there is still the cost of labor to record data on a daily basis, as well as enter, compile and analyze the data. For smaller operations, therefore, the expense involved in the diary system is challenging to afford or to justify (Interviews C18, U13, U23). Either a high level of technical assistance or grant funding is needed (Interview U23).

When using diaries to track FLW, it is critical that there is ongoing communication between management and staff, to ensure that the system is used correctly, that results are communicated back to staff, and that the data are used to adapt operations (Interview U6). Data need to be monitored continuously and ongoing technical support must be provided, to achieve long-term results (Interviews C21, U23).

Specific challenges and considerations in each country are highlighted below.

Canada: According to the Provision Coalition, of the 6,000 food and beverage manufacturing facilities in Canada, 90% are classified as small or medium-sized enterprises (SMEs). In the retail and accommodation and foodservice sectors, SMEs represent the vast majority of businesses, accounting for 675,613 in 2015 (Government of Canada 2016b). SMEs do not have resources such as full departments to deal with sustainability issues and track FLW on an ongoing basis with diaries (Interviews C24, C26). Therefore, implementing FLW diaries is for SMEs more challenging.

Mexico: Staff training can incur significant upfront costs. Small and medium-sized ICI stakeholders in Mexico generally do not have internal resources to track FLW and therefore will require funding from a third party for implementation (Interview M82).

United States: Compared to in many other countries in the world, in the United States, food is inexpensive relative to income levels (Chandler 2016). As a result, the material cost of food is much lower compared to the cost of staff time, which creates a disincentive for ICI stakeholders to implement FLW diaries. This dynamic became evident in a study conducted at University of California Berkeley, which noted that 38% of restaurants in the area are not measuring or tracking FLW in any way (Sakaguchi 2016).

A summary of key considerations for implementing the diary approach is presented in TABLE 34.

TABLE 34. Key Considerations for Implementing Approach 2: Diaries

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium to High**	Depending on the diary system employed, there may be some costs associated with training and system set-up. Simpler systems would have a lower cost, and technology-based systems would have a higher cost. Profit margins for foodservice establishments, especially SMEs, are low, so any system would need to ensure profitability.
Savings (financial savings as a result)	**Medium**	The data collected from diaries and actions enable stakeholders to reassess operational practices, in order to lower FLW, which will subsequently reduce food procurement costs. However, the savings in materials may be offset by more staff time or operational costs. Having less FLW could also save on disposal fees.
Time to Implement (length of time needed to operationalize change)	**Short to Medium**	The range of methods, from paper-based systems to more advanced technology, can help with uptake of measuring and tracking. Technology-based systems are expected to need more time (6 to 12 months) to implement.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	Buy-in is needed at each level of an organization, from executive-level management to middle-management (e.g., chefs) to laborers (e.g., prep cooks, floor staff, and factory workers).

5.4.2.4 Example Initiatives

Canada:

- Metro Vancouver Regional District collaborated with LeanPath to develop a pilot program, offering the LeanPath technology and supplementary technical support to several foodservice operations in the area (Metro Vancouver n.d.).
- Compass Group Canada committed to implementing FLW tracking programs using diaries in 100% of their foodservice locations (Compass Group 2014).

- Gordon Foodservice, a food distribution company, is working with customers to reduce kitchen waste and has developed its own inventory management software to help clients measure and reduce FLW (Gordon Foodservice 2015).

Mexico:

- There were no documented examples found in literature of diaries used in the ICI sector, , but there was one example of a case where FLW from residential dwellings in Mexico City was measured using a self-reported kitchen diary (Jean-Baptiste 2013). Although the diary approach targets consumers, it could have applications in the ICI sector. More information can be found in Case Study 22.

United States:

- LeanPath is a fully automated FLW tracking and prevention system, primarily used in foodservice businesses. LeanPath includes customizable software that helps ICI stakeholders record every food type and reason for loss in a diary format and automatically captures the value of the waste. This initiative is further explored in Case Study 23.
- Stop Waste partnered with LeanPath on the Smart Kitchen initiative, which supports several businesses in the Bay Area, California, through use of a model of grant funding and technical assistance that encourages foodservice partners to track FLW, using a diary approach.
- Compass Group uses their own system and process, TrimTrax, a diary format, to measure FLW on university campuses (Compass Group 2012).

5.4.3 Approach 3: Surveys

5.4.3.1 Description

FLW surveys use a set of structured questions to collect quantitative, self-reported data or qualitative information such as attitudes, beliefs and self-reported behaviours (WRI 2016). Surveys typically are conducted among a representative subset of a population or sector that is large enough to capture the expected trends of the whole population or sector. They can be implemented in person, via telephone or online, with individuals or a group. Outputs of surveys can be used to inform sector-mapping, baseline analysis, or program design for FLW. Surveys can be used by federal, state and local governments to acquire measurement of FLW.

5.4.3.2 Trends

Surveys are a common method for collecting information about FLW across North America. Most surveys initiated by a government agency or an industry group target the ICI sector. There are also many surveys targeting consumers, conducted by academics for research projects. The focus of this section is on the ICI sector, where fewer data are available.

Survey questions generally include:

- estimates of FLW generated;
- reasons food became waste;
- how FLW is managed; and
- input on opportunities to increase reduction of FLW, and improve food rescue or recovery.

Specific trends in each country are highlighted below.

Canada: Statistics Canada conducts an industry survey on waste management that targets stakeholders such as landfill operators, material-recovery facilities, organics processors, and waste haulage companies to estimate quantities of solid waste disposed of in Canada, including FLW (Giroux 2014, 121). The most recent survey was conducted in 2012.

In 2013, the Provision Coalition conducted the study published as *Developing an Industry Led Approach to Addressing Food Waste in Canada* to map out the FLW challenges and make recommendations for the agri-food industry in Ontario and in Canada as a whole. After conducting a review of the literature, interviews with key stakeholders, and a working session with stakeholders, Provision Coalition presented problem and stakeholder maps, identified key issues concerning FLW, and pointed out opportunities to address them (Provision Coalition 2014, 5).

Food and Consumer Products of Canada (FCPC) distributed a climate change survey to 46 members in 2015, and 16 companies responded (Food and Consumer Products of Canada 2015, 3). The survey had questions on FLW, including questions related to measuring, tracking and diversion strategies. Most (92%) of the respondents reported measuring and tracking FLW at their plants in Canada; however, not all respondents reported tracking exact quantities, using a waste management method (Food and Consumer Products of Canada 2015, 9).

Mexico: National surveys from several government institutions provide key information to estimate FLW, mostly on the production stages of the food supply chain. The Agri-Food and Fishery Information Service (*Servicio de Información Agroalimentaria y Pesquera*—SIAP) conducts surveys on crop density as well as yield. The Agency for Services to the Marketing and Development of Agricultural Markets (*Agencia de Servicios a la Comercialización y Desarrollo de Mercados Agropecuarios*—Aserca), a program of Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*—Sagarpa), conducts surveys that cover 90% of the agricultural producers in the country. The Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*—SCT) collects surveys on transported loads and their routes, and on other details that can be used as a baseline to estimate FLW.

United States: A few municipalities have conducted surveys of the ICI sector, on FLW. For example, the City of Seattle recently conducted an FLW study in which it interviewed five grocery stores and seven foodservice outfits. The study found that all businesses used some metrics, focusing on either weight or dollar value, to measure FLW (University of Washington Center for Public Health Nutrition 2016). The State of Connecticut surveyed FLW generators to quantify and characterize the organic waste generated by these facilities. These surveys were paired with waste composition analyses. The data were then used to map the location of FLW generators and identify areas with large amounts of FLW that could benefit from food rescue or recovery infrastructure (Draper/Lennon, Inc., and Atlantic Geoscience Corp 2001). In Oregon, a statewide baseline study was launched in early 2017, designed to fill measurement and knowledge gaps on what food is wasted, how much is edible and the underlying causes of FLW; a substantial amount of the data on behaviors was collected via surveys (Interview U26). The study involved analysis of household FLW through sorting of waste, surveys, interviews and FLW diaries, and included a set of 25 commercial case studies aimed at prototyping or validating waste-prevention practices in various contexts (Interview U26).

The Food Waste Reduction Alliance (FWRA) conducted a three-year study and issued the first-ever analysis of FLW in the US food industry, using data collected directly from manufacturers, retailers and wholesalers. This study relied heavily on surveys and self-reported data from members. The FWRA found that, compared to 2011, more food manufacturing, wholesale, and retail companies were expanding their tracking and reporting of FLW data, and this trend is expected to continue in the future (BSR 2014, 22).

In January 2014, the National Restaurant Association conducted a phone survey of 1,000 restaurant operators, about their interest in sustainability. When asked if they track the amount of FLW on a regular basis, 79% of quick-service restaurants and 70% of full-service restaurants responded affirmatively, although there continue to be challenges concerning regularity of measurement and the quantifiable outcomes from these measurements (NRA 2014).

5.4.3.3 Challenges and Special Considerations

Estimating waste at the level of individual food industries requires detailed survey information, due to the diversity among business types and sizes in the food sector (UNEP 2014). The methodological challenge with surveys is that they rely on self-reported data and it is common for respondents to under-report their FLW or be inconsistent, because each respondent uses a slightly different way to estimate its FLW.

Survey sample size and representation are crucial to obtaining accurate information on FLW. One challenge with surveys is that they tend to be voluntary. Survey respondents tend to be those who are already engaged in or interested in FLW. Therefore, there is the potential for bias, which may skew results or generate results that are not representative of the sector as a whole. This challenge can be mitigated by linking surveys to waste composition analyses; however, food businesses are generally hesitant to allow researchers to access their waste for a composition study. The main challenge is the perception that data may still be disclosed, even when the results are anonymized. Lastly, bias can be introduced in the way that questions are phrased or asked, and that can affect how respondents answer.

Specific challenges and considerations in each country are highlighted below.

Canada: As indicated by the member survey conducted in 2015 by Food and Consumer Products of Canada (FCPC), voluntary efforts to collect FLW data from companies can suffer from low response rates (16 out of 46 members) (Food and Consumer Products of Canada 2015, 3). While FCPC considers the sample representative, having data missing from 30—or 65%—of its members could lead to unreliable results when scaled to the industry as a whole.

Statistics Canada conducts a waste management survey that estimates the quantities of ICI-sourced waste. However, the survey does not include ICI-sector generators. This creates a data gap in information on the causes behind why FLW is generated by food businesses, as well as on waste that is handled outside of the waste management industry, such as that going to animal feed, or food rescue.

Mexico: Most of the data collected in Mexico from surveys use proxy variables to infer the quantities of FLW, as opposed to getting the quantities through direct questions on FLW generation. Questions specific to FLW, such as behaviors of various stakeholders, or quantification, are typically not included.

United States: Although momentum and awareness concerning FLW are growing in the food industry, the lack of publicly available data for each sector in the food supply chain prevents accuracy in estimate quantities (BSR 2012, 6). The main challenge in getting businesses to answer surveys, especially those members of the wholesale and retail industry, is a perception that the survey may release confidential information (BSR 2013, 21). Some selection bias may exist: earlier adopters of measurement programs may be more willing to answer such surveys. Furthermore, measurement, tracking and reporting require businesses to invest time, labor and capital.

A summary of key considerations for implementing the survey approach is presented in TABLE 35.

TABLE 35. Key Considerations for Implementing Approach 3: Surveys

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Low**	Specialized marketing firms offer competitive pricing for conducting surveys that get high response rates and provide the information needed for informing program development.
Savings (financial savings as a result)	**Medium**	Survey results can be used to highlight key challenges and drive solutions, resulting in cost savings for the stakeholder using the survey.
Time to Implement (length of time needed to operationalize change)	**Low**	Surveys can be developed and implemented within a short-term period—as little as one or two months.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**Medium**	There can be considerable value to better understanding a key user or stakeholder group, and surveys help to fill that information gap, which adds overall appeal for buying in to their use.

5.4.3.4 Example Initiatives

Canada:

- Food and Consumer Products of Canada (FCPC) surveyed its members to collect information on how members are managing FLW at their plants. FCPC will use the information to develop a sector-specific strategy for setting reductions goals for FLW to landfill (Food and Consumer Products of Canada 2015, 8).
- Statistics Canada includes questions about organic waste and the amount of food waste in organic waste, as part of its bi-annual survey of waste management in industry (Giroux 2014, 121).
- Provision Coalition conducted surveys of stakeholders in the food-manufacturing industry, to inform the report *Developing an Industry Led Approach to Addressing Food Waste in Canada* (Provision Coalition 2014, 5).

Mexico:

- The Agri-Food and Fishery Information Service (*Servicio de Información Agroalimentaria y Pesquera*—SIAP) conducts surveys on crop density and yield (Servicio de Información Agroalimentaria y Pesquera 2017).
- The Agency for Services to the Marketing and Development of Agricultural Markets (*Agencia de Servicios a la Comercialización y Desarrollo de Mercados Agropecuarios*—Aserca), a division of the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*—Sagarpa), conducts surveys that cover 90% of the agricultural producers in the country (Tenorio 2016).
- The Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*—SCT) collects information on transported loads and their routes, through permits and legal requirements (Morales 2016).

United States:

- The US EPA is developing a map that shows potential generators and recipients of wasted food, along with a report that identifies the methodologies used to estimate food-waste generation from the following industry sectors: food manufacturers and processors, food wholesalers and distributors, educational institutions, the hospitality industry, correctional facilities, the healthcare industry, and food banks.

- The City of Seattle surveyed grocery stores and foodservice outfits about FLW and found, through questions about measuring and tracking, that all businesses surveyed used some metrics to determine quantities of FLW (University of Washington Center for Public Health Nutrition 2016).
- The State of Connecticut surveyed FLW generators to analyze waste composition, and quantify and characterize the organic wasted generated. The data were mapped to identify areas that could benefit from rescue and/or recovery infrastructure because of large amounts of surplus food generated (Draper/Lennon, Inc., and Atlantic Geoscience Corp 2001).
- The Food Waste Reduction Alliance (FWRA) surveyed manufacturers, retailers and wholesalers on quantities of FLW and FLW management behaviors, for a three-year study on FLW in the United States. The study found that there is an increasing trend among companies to track and report FLW (BSR 2014, 22) (see Case Study 24).
- The National Restaurant Association conducted a phone survey of 1,000 restaurant operators that was on sustainability and included questions on measuring and tracking FLW. It found that 75% of restaurants track FLW (NRA 2014).
- In 2015, the South Carolina Department of Commerce carried out a project whose results were published as *South Carolina Food Waste Generation Report*, and which created a database of FLW generators in South Carolina based on surveys to assess the availability of organic waste from commercial and industrial sources (South Carolina Department of Commerce 2015).

5.4.4 Approach 4: Models and Extrapolation of Proxy Data

5.4.4.1 Description

Although the FLW Standard addresses models and proxy data separately (WRI 2016), these two approaches are often used together and therefore are presented in this report as one approach. Mathematical models use as inputs multiple factors that influence the generation of FLW, then assign equations and metrics to each factor (WRI 2016). Models are typically developed with available data specific to the target sector or region, in combination with extrapolations of proxy data. Proxy data are information that is obtained from another comparable country, region or company (depending on the type of data), or are older information that is modified for changed conditions (e.g., applying a factor to account for population growth) (WRI 2016). Due to the limited amount of FLW data, the vast majority of models contain some proxy data to fill data gaps. Surveys can be used by federal, state and local government levels as an approach to FLW measurement.

5.4.4.2 Trends

Of the approaches to measuring, tracking and reporting, most of the published reports and studies used a combination of models, and extrapolation of proxy data. This approach requires less primary data collection, which reduces the resources required to collect, compile and tabulate the data. In North America, common approaches for mathematical modeling for quantification of FLW include loss factors (estimated or calculated percentages of FLW in each stage of the food supply chain), per-capita generation of FLW, or estimates based on data from disposal facilities (Interviews C42, M21, U18):

Loss factors are the most common method and have been applied in all three countries. The approach uses data on food availability (i.e., the amount of food produced or available for consumption) and assigns factors—such as percentages lost at various stages of the food supply chain—for a number of food products.

Per-capita generation is a method of estimating FLW quantities based on the average amount of FLW produced per person. It is a common way to complete quick and high-level estimates. The FLW generation per capita is usually taken from another data source; for example, the regional per-capita estimates from the Food and Agricultural Organization (FAO), by Gustavsson et al. (2011). When data are scarce and resources are limited, using proxy data such as per-capita generation can give rough approximations of FLW in aggregate, but generally does not give enough detail on the types of food or how much is wasted along different parts of the supply chain.

Disposal facility–based estimates are a way to use waste-composition data or any self-reported estimates by disposal facilities, collected via surveys, for mathematical modeling. With this approach, waste-composition percentages are applied to overall tonnages at disposal facilities to estimate the amount of food being disposed of. This method generally only includes estimates of food in municipal solid waste (MSW), which excludes agricultural waste.

Specific trends in each country are highlighted below.

Canada: Agriculture and Agri-Food Canada (AAFC) applied FLW data sources from FAO, World Resources Institute (WRI), Statistics Canada, United States Department of Agriculture (USDA) and US EPA (Agriculture and Agri-Food Canada 2015a, 15–20) to determine the state of FLW at all stages of the agri-food system (Agriculture and Agri-Food Canada 2015a, 10). AAFC also has conducted preliminary estimates of FLW, using food availability data and working with researchers from the United States Department of Agriculture Economic Research Services (USDA ERS) to evaluate how American factors can apply to a Canadian setting (Interview C42, Rich 2014).

Value Chain Management International (VCMI) has published four reports on Canada's food and associated waste since 2010. VCMI's widely referenced 2014 report *"$27 Billion" Revisited: The Cost of Canada's Annual Food Waste* used a mathematical model to estimate the value of FLW in Canada as equal to C$31 billion in 2014— a 15 percent increase from the 2010 estimate of C$27 billion (Gooch et al. 2014). The inputs to the model included assumptions by VCMI on FLW from various parts of the supply chain, based on the company's industry experience as well as on proxy data from sources such as the USDA for per-capita FLW at the consumer level.

Mexico: Efforts have been made to quantify FLW at a national level by tracking the flow of individual products in certain regions. This method has been employed by the Institute for Planning Development (IPD), Sagarpa, the Ministry of Social Development (*Secretaría de Desarrollo Social*—Sedesol) and the World Bank. The IPD estimated FLW along the food supply chain of bitter lemons, golden mangos, oranges, melons, papayas and tomatoes in the state of Oaxaca (IPD 2014). Sagarpa used a similar approach to IPD and found approximately 30% of mango is wasted across the mango supply chain (Interview M77). Sedesol developed an estimate of FLW based on a list of 34 products considered to be basic components of a Mexican diet. The World Bank used a similar modeling approach, but instead with 79 products representative of the Mexican diet.

United States: The USDA's Economic Research Service (ERS) estimated FLW using a loss-adjusted food availability (LAFA) data series. The loss assumptions in the LAFA data are used to estimate the amount and value of FLW at the consumer and retail levels in the United States, based on food production inputs. This data series is used in the widely cited study, *The Estimated Amount, Value, and Calories of Preharvest Food Losses at the Retail and Consumer Levels in the United States*, measuring uneaten food from businesses and homes (Buzby et al. 2014).

The US EPA estimates FLW quantities by estimating the amount of food going into municipal solid waste (MSW). For more than 30 years, EPA has tracked data on generation and disposal of MSW as part of its measure of success of programs for waste reduction and recycling (US EPA 2016c). Food waste consists of uneaten food and food-preparation discard from residences, commercial establishments such as grocery stores and sit-down and fast food restaurants, institutional sources such as school cafeterias, and industrial sources such as factory lunchrooms (US EPA 2014). Preconsumer food waste generated during the manufacturing and packaging of food products is considered industrial waste and therefore not included in MSW food waste estimates.

Food waste from residential and commercial sources is estimated using factors based on data from sampling studies in various parts of the country, in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and numbers of students, patients and prisoners in institutions (US EPA 2014). Composting of food waste is estimated from state agency data. The residential and commercial source factors are reviewed and revised as more sampling studies become available.

ReFED estimated FLW data by analyzing and integrating primary and secondary research and the results of previous studies on FLW. ReFED estimated the quantity of FLW as well as the economic and non-financial impacts of FLW reduction. These estimates were developed through extrapolations of data from previous studies or from proxy indicators of waste quantities, such as employee numbers. ReFED estimated that implementing its 27 recommended strategies could divert 12 million tonnes of food from landfills and farm losses (ReFED 2016, 12).

NRDC estimated FLW in the United States by examining existing statistics. The headline statistic was derived from a study (Hall et al. 2009) that estimated the energy content of FLW by comparing the United States food supply data (collected by USDA) with estimates of food consumed by the population (modeled based on US National Health and Nutrition Examination Survey data). The estimated FLW at every level of the US supply chain (farming, post-harvest and in packing, processing, distribution, retail, foodservice and household) was based heavily on the North America and Oceania regional estimates by Gustavsson et al. (2011).

5.4.4.3 Challenges and Special Considerations

FLW estimations are often extrapolated from proxy data, which results in wide variations among different national studies due to the compounding of assumptions in the approximations. This challenge was evident in the presentation of FLW data in Section 2.2. Significant variations in national FLW methodologies and in the definitions used by different organizations prevent a full analysis according to geography or across the entire food supply chain. These variations also make it more challenging to compare studies to each other, due to the differences among them in scope, assumptions, definitions and interpretation.

Although models and proxy data have been used in numerous studies and reports, one of the biggest risks in relying on these approaches alone is that once a result is published, it is often interpreted with a high degree of certainty, even though the margin of error of the model may be high. In addition, once a report is cited a few times or promoted by a recognized entity, it may be relied on heavily, which can result in a perception of more accuracy and certainty than was available when generating the report. This can be mitigated by clearly defining the data sources, quantification methodology, and confidence level of the results provided in the report.

It is common for the background assumptions, calculations and analyses of the confidence of the data to be buried in appendices, which are typically not read or well understood by the average reader. One way to mitigate these challenges is to disseminate with these reports an educational opportunity (e.g., conference tutorial, webinar), to help readers adapt the methodology for their own uses.

Specific challenges and considerations in each country are highlighted below.

Canada: Many of the models of FLW quantification in Canada have relied on proxy data from the United States. Although there are many similarities between the two countries, there could be some geographical and cultural differences that may not be completely captured when adapting American data for the Canadian context. For example, the population in Canada is approximately 10% that of the

United States (World Bank 2015b). In addition, Canadian food prices are often much higher than their American counterparts (Investopedia 2010).

Mexico: The approaches for quantifying FLW in Mexico have relied heavily on mathematical models for specific products in the food supply chain, meaning the models are not inclusive of all types of food that are wasted in the country. These methods could underestimate the amount of FLW or may not capture food rescued or recovered through informal means.

United States: The United States has the most developed and comprehensive mathematical models for quantifying FLW in North America. However, results should be interpreted with some degree of caution and using cross-comparison with available primary data, because models are typically based on estimates or extrapolations from limited data sets (Interviews U1, U4; Gunders 2012, 9).

A summary of key considerations for implementing the approach of models and proxy data is presented in TABLE 36.

TABLE 36. Key Considerations for Implementing Approach 4: Models and Proxy Data Extrapolation

Key Consideration	Rating	Explanation of Rating
Cost (additional cost needed to implement approach)	**Medium**	Developing functional models and extrapolating data require qualified personnel and the appropriate quality control and assurances processes, and can be time-consuming and costly.
Savings (financial savings as a result)	**Medium**	Better understanding waste at different levels of the food supply chain can result in development of initiatives to support waste reduction, which would deliver some savings.
Time to Implement (length of time needed to operationalize change)	**Medium**	Studies involving more-complex analysis, with a range of inputs, can take considerable time, several months, depending on what inputs are available.
Anticipated Level of Stakeholder Support (the level of buy-in for this approach)	**High**	Well executed analysis to provide more-accurate measurement results can be valuable to a broad range of stakeholders and can have a high level of buy-in.

5.4.4.4 Example Initiatives

Canada:

- Statistics Canada estimated FLW at the retail and consumer levels by using adjustment factors with data from the USDA on available food, adjusted for retail, household, cooking and plate loss (Statistics Canada 2009).
- VCMI estimated the dollar value of FLW in Canada by using a combination of proprietary food industry data and published information from Statistics Canada, so as to build the financial case for businesses to evaluate their operations (Gooch et al. 2014). Further details can be found in Case Study 26.
- AAFC conducted preliminary estimates of food availability and food loss by using food availability estimates and food availability loss factors from the USDA (Interview C42).
- In the report entitled *The Importance of Quantifying Food Waste in Canada*, FLW was estimated by using historical data from 1961 to 2009. The details of the report are discussed further in Case Study 25.

Mexico:

- Sedesol led a study in 2013 which estimated total FLW by using 34 food products that represented the Mexican diet (Aguilar Gutiérrez 2013).
- MD Consulting led a study for Sedesol in 2015 (currently under revision, and no published data are available) which estimated percentages of FLW at each stage of the supply chain. This study also compared the methodology used for the study with methodologies used in 2013 by Sedesol (see bullet above) and with a methodology based on FAO factors for Latin America (MD Consultoría 2015).
- IPD conducted a study that used a combination of 28 matrices to estimate FLW at each stage of the food supply chain. This is considered a third-level methodology (Interview M46).
- The World Bank conducted a study that estimated total FLW and environmental impacts by using a food basket of 79 products representing the Mexican diet (Aguilar Gutiérrez 2016). More details can be found in Case Study 27.

United States:

- The USDA Economic Research Service maintains the Loss-Adjust Food Availability (LAFA) Data Series for over 200 agricultural product types. It estimates the quantity, value and calories of FLW at the retail and consumer levels by using data for food supply and sales (Buzby et al. 2014). More information can be found in Case Study 28.
- The US EPA used a materials-flow model to estimate the quantity of FLW generated, composted, combusted, and disposed of in landfills, based on waste composition analyses (US EPA 2016c).
- The US EPA is developing a map displaying potential generators and recipients of wasted food across the country, and including establishment-specific volume estimates (US EPA 2016f).
- NRDC used available data from the FAO and the National Institute of Health to estimate quantities of FLW in the United States across the food supply chain (Gunders 2012).
- ReFED combined available data sets found in the United States and internationally to estimate FLW at each stage of the supply chain (ReFED 2016).

5.5 Policy and Education/Awareness Programs

There are opportunities for policies and education/awareness programs to support various approaches to FLW and its measuring and tracking, and to help move them forward. This section presents examples of promising policies and programs that are implemented globally, regionally in North America and in each of the three countries.

5.5.1 International

An increasing number of international conferences are addressing food loss and waste reduction, featuring the topic of FLW measurement (FAO 2016, 4). A summary of the key global findings and recommendations included the following (FAO 2016, 39):

- Establish multi-dimensional and cross-sectoral partnerships for FLW measurement and metrics.
- Consider data collection that incorporates local and cultural nuances, to obtain more-appropriate frameworks for assessments of food loss and waste.
- Promote the newly developed Food Loss and Waste Accounting and Reporting Standard.

- Build global collaboration on measuring FLW, to create data that are more reliable and can be used to inform investments in the most strategic areas and with the most appropriate solutions (FAO 2016, 31).

International FLW initiatives such as the UN's Sustainable Development Goal 12.3, the related Champions 12.3 coalition and the United Kingdom's Waste and Resources Action Programme (WRAP) are discussed in Section 3, above. Examples of global and trans-national policies and programs related to FLW measurement, tracking and reporting are summarized below. In addition, seven case studies that go into more detail on these approaches are described in Section 9.

The Technical Platform on the Measurement and Reduction of Food Loss and Waste was launched in 2015, by the FAO, the International Food Policy Research Institute (IFPRI), and the CGIAR Consortium of International Agriculture Research Centers program on Policies Institutions and Markets (PIM). This information-sharing forum enhances global cooperation and knowledge-sharing of best practices on measuring and reducing food loss and waste. The online platform facilitates information exchange and coordination among diverse stakeholders at local, regional and national levels (FAO 2016b).

The Food Loss and Waste Protocol (FLW Protocol) is a leading initiative in the international effort to examine and quantify FLW. Launched in 2013, the FLW Protocol encompasses a global multi-stakeholder partnership. The FLW Protocol's Steering Committee consists of the World Resources Institute (WRI) (as Secretariat), The Consumer Goods Forum (CGF), Food and Agriculture Organization of the United Nations (FAO), European-Union-funded FUSIONS project, United Nations Environment Programme (UNEP), World Business Council for Sustainable Development (WBCSD) and the United Kingdom's Waste and Resources Action Programme (WRAP). In June 2016, the FLW Protocol released the FLW Standard, which provides the first global accounting and reporting standards for quantifying and identifying where food loss and waste occur along the food supply chain. The FLW Standard is intended to enable FLW data collection, but the governing entity will not collect the data itself. The FLW Standard contains guidance, resources and examples that can be used by governments, businesses and other organizations to measure and manage FLW. It addresses the challenges of and need for a universal definition of "food loss and waste" in an inventory. It does not describe specific and required measurement methods, but instead provides options and allows relevancy and flexibility for countries and food-sector entities (Interview I2).

The EU *Food Waste Quantification Manual* is a major reason why the European Union (EU) has been considered the leader in FLW measurement/quantification. In June 2016, the EU Council called upon member states to improve waste monitoring and data collection. On the same date, the EU Council also approved FUSIONS' (Food Use for Social Innovation by Optimizing Waste Prevention Strategies') *Food Waste Quantification Manual* (EC 2016) (see Case Study 35).

5.5.2 North America

The three North American countries are currently collaborating on FLW through the Commission for Environmental Cooperation, whose focus areas include measuring, tracking and reporting. Although there are no specific policies or programs in place on the topic of measuring, tracking and reporting FLW across North America, there are opportunities for the three countries to collaborate to adopt initiatives, as outlined in Section 5.5.1.

One such opportunity is for all countries to consistently adopt a standard methodology for measuring, tracking and reporting so that there are consistent data and there is agreement on definitions such as FLW, inedible food and edible food. The countries could also work together to raise awareness of measuring, tracking and reporting FLW among multi-national companies that generate FLW in each country, with the aim of adopting a standardized method.

5.5.3 Canada

5.5.3.1 Government

Some Canadian federal government departments (e.g., Statistics Canada, Environment and Climate Change Canada, and Agriculture and Agri-Food Canada) are beginning to identify opportunities and approaches to improve FLW measurement in Canada.

The Government of Ontario’s Waste Audits and Waste Reduction Work Plans regulation under the Environmental Protection Act (Regulation 102/94) requires food- and beverage-processing facilities to conduct annual waste audits if the number of total hours worked by employees at the site has exceeded 16,000 during any month of the previous two years (Government of Ontario 1994). The waste audit must quantify the amount, type and composition of waste in the facility, as well as provide details on how waste is produced and managed. It also requires that a waste reduction plan be conducted, explaining methodologies to reduce, re-use and recycle waste.) Although these waste audits do not specifically target FLW, FLW generated by a facility should be reported as part of the waste audit.

5.5.3.2 ICI

Provision Coalition identified a need for a consistent definition of FLW and a way to measure and track FLW at the plant level. It developed an online toolkit to help manufacturers quantify FLW, calculate the value of this waste (disposal costs) and implement best practices to reduce avoidable food/beverage waste at the source. (Provision Coalition 2017).

The Recycling Council of Ontario is an industry association that promotes waste reduction and recycling in the province. It has a program called 3RCertified, a voluntary certification that recognizes organizations from the ICI sector who are leaders in waste reduction and diversion. The program includes tools and resources to help businesses measure their waste, such as a Standard Waste Audit Methodology, Waste Auditor Training Program, and Accredited Waste Auditor Program (Recycling Council of Ontario n.d.). Again, these programs are not FLW-specific, but could apply to FLW measurement, tracking and reporting.

5.5.4 Mexico

5.5.4.1 Government

The Ministry of the Environment and Natural Resources’ (*Secretaría del Medio Ambiente y Recursos Naturales*—Semarnat) NOM-161-SEMARNAT-2011 legislation establishes the criteria for classifying different categories of “special waste management.” Furthermore, it also defines which categories require management plans from operators (Semarnat 2011). Under this legislation, commercial operations and service companies that produce more than 10 tonnes of waste per year are required to report the waste they generate and present a waste management plan that describes the treatments and final destination of each type of waste generated, along with measures to minimize and recycle their waste. Although this requirement for reporting of waste applies to all material types, FLW is included in the reports.

Sedesol and IPD have been the institutions leading the quantification of FLW along the food supply chain. They have, through partner organizations and consultants, developed different methodologies to estimate FLW. In 2016, Conacyt funded the establishment of a researchers' network whose purpose is to focus on developing a methodology for measuring FLW across the food supply chain (Conacyt 2016; Interview M4). The network has started disseminating information and hosting symposiums in different regions of the country so as to connect organizations that are working on measuring, tracking and reporting and develop a work plan (Interview M4). Examples of such events include the National

Symposium of Losses and Food Waste (*Simposium nacional de pérdidas y desperdicos de alimentos*) in La Laguna, Querétaro and Michoacán (Interview M4).

The Center for Cleaner Production (*Centro Mexicano para la Producción Más Limpia*) has been investigating the generation of organic waste in the foodservice industry, but is currently not pursuing quantification (Interview M1).

At the state level, Mexico has mandated since 2004, through the General Law of Waste Prevention and Integral Management, that state governments work on programs for waste prevention and management. Under this law, waste assessments should be conducted by state governments. More than 20 states have developed programs in which waste composition analyses are conducted. Statewide waste composition analyses typically include FLW and are reported in the Mexico Landfill Gas Model (Stage and Davila 2009).

5.5.4.2 ICI

Within Mexico, some large multi-national corporations such as Walmart and Unilever conduct internal measuring, tracking and reporting of food and organic waste. They generally follow policies for these activities that are developed outside Mexico and are standardized globally or by region (Interview M58). One example of an ICI tool that incorporates measuring, tracking and reporting is the System of Integral Measurement and Productivity Improvement (*Sistema Integral de Medición y Avance de la Productividad*—Simapro). This tool was developed by the International Labor Organization (ILO) to increase sustainability of operations through assessment of current practices and measurement, and to identify opportunities for improvement (Section 3.5.4.2).

5.5.5 United States

5.5.5.1 Government

The US EPA's Food Recovery Challenge includes elements of measuring, tracking and reporting as part of the program. Specifically, Food Recovery Challenge participants quantify, manage and report on their FLW program through EPA's online tracking and reporting software database (called the Sustainable Materials Management [SMM] Data Management System) and receive technical assistance. After assessing the scale of FLW, entities can use the US EPA Hierarchy to evaluate and adopt other FLW prevention and reduction practices (Interview U21).

The US EPA collects data from participants and annually recognizes leaders, through its Food Recovery Challenge Awards, which include an award category for "Best Data-Driven Improvement" (by sector). In 2016, more than 950 Food Recovery Challenge participants and endorsers prevented and diverted over 740,000 tons of wasted food from entering landfills or incinerators (US EPA 2017c).

To drive next steps and engagement to reach the 2030 FLW reduction goal, EPA and USDA announced the formation of the US Food Loss and Waste 2030 Champions, a group of businesses and organizations that have made a public commitment to reduce FLW in their own operations in the United States by 50% by the year 2030. 2030 Champions are responsible for setting their own baselines and measuring their own FLW reductions. They commit to reporting on their progress, on their websites.

Opportunities and actions suggested by stakeholders for measuring, tracking and reporting are presented in TABLE 37.

TABLE 37. Actions for Measuring, Tracking and Reporting, by Stakeholder Group

Stakeholder	Who Is Involved	Opportunities Highlighted by Stakeholder	Actions Suggested by Stakeholder
Regulators and Policy Makers	- Federal government - Local government - State government - Tribal government - NGOs	- Gain a better understanding of the size and impacts of food loss and waste. - Help create standard tools for measurement and data analysis.	- Develop and publish a standard measurement tool. - Establish a process for documenting and tracking progress toward the 2030 FLW reduction goal.
Retail and Foodservices	- Grocers - Restaurants - Vendors - Cafeterias - Food pantries / food banks - Transporters	- Create standard measurement procedures to improve tracking the scope and size of FLW generation.	- Collect data on quantity of waste, food donation levels and reasons for waste, within retailer's inventory management systems. - Utilize available resources and tools to measure and track FLW. - Join EPA's Food Recovery Challenge, to benchmark progress toward waste reduction goals.

Source: US EPA 2016.

In addition to the Food Recovery Challenge and Call to Action, the US EPA supports an online State Data Measurement Sharing Program (SMP). The SMP is an online toolkit that tracks annual waste tonnages and financial summaries of waste and recycling programs. The information submitted to SMP generates a series of annual analytical reports on waste at state, regional and national levels (US EPA 2016c).

5.5.5.2 ICI

One example of an ICI sector–led program for measuring, tracking and reporting FLW is the Food Waste Reduction Alliance's (FWRA's) FLW quantification working group. The goal of this group is to assess, analyze and reduce FLW, both collectively and individually, among food retailers, wholesalers, manufacturers and restaurants. The group develops methods for measurement and quantification so that there is a consistent approach among member organizations. FWRA also disseminates among its members case studies of best practices, to encourage FLW quantification.

6 Linking Food Loss and Waste to Greenhouse Gas Emissions and Other Environmental and Socio-Economic Impacts

There are significant environmental and socio-economic impacts caused by food loss and waste (FLW) across the supply chain. Reducing the generation of wasted food is a key solution to reducing greenhouse gas (GHG) emissions. Therefore, the primary focus of this section is the GHG emissions from FLW, and the potential for their reduction (Section 6.1). FLW also creates other environmental and socio-economic impacts, which are discussed in Section 6.2.

6.1 Greenhouse Gas Impacts

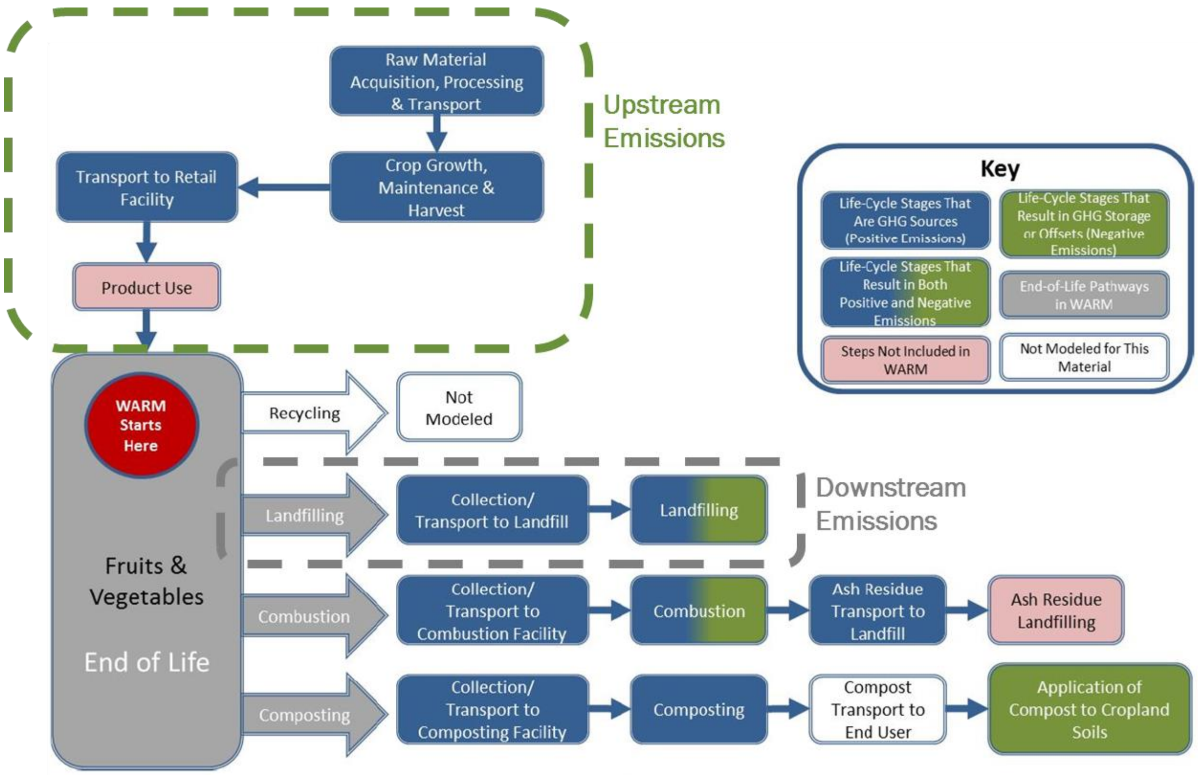
FLW contributes to GHG emissions during two overall stages in its life-cycle (US EPA 2015a, 1–12):

- upstream—from production, processing, distribution, retailing and consumption; and
- downstream—from waste collection, transport and other operations, and from the decomposition of food after disposal in landfills (which generates methane).

Note: The GHG emissions quantification in this section (6.1) applies only to landfilled FLW.

FIGURE 9 presents an illustration of potential sources of life-cycle GHG emissions associated with FLW, from fruits and vegetables (US EPA 2015a). This diagram shows some stages of upstream emissions and downstream emissions that are not covered in the scope of this report: Upstream emissions include food production (pre-harvest and post-harvest) and processing and distribution (including retail and foodservice) but not covered in this report, consumption. Downstream emissions covered in the scope of this report include only collection, transport and landfilling activities, and not combustion or composting. Similar diagrams for other categories of FLW are presented in the Organic Materials chapters of the US EPA's Waste Reduction Model (WaRM) documentation (US EPA 2015a).

FIGURE 9. Greenhouse Gas Emission Sources from Fruits and Vegetables



Source: Adapted from US EPA 2015b, 18-3.

This section introduces methodologies used globally and in North America for quantification of GHG emissions. The background information provided below can be used to interpret the findings in subsequent parts of this section that cover direct GHG emissions (i.e., methane from landfills) and life-cycle GHG emissions.

6.1.1 Quantification Methodologies and Available Tools

Most of the existing methodologies focus on methane emissions from landfills by using an inventory approach, which only includes direct emissions from organic material (including FLW) degrading under anaerobic conditions (Pipatti and Svardal 2006, 3.5).

Carbon dioxide, nitrogen oxides, carbon monoxide and nitrous oxide are produced along with methane. The Intergovernmental Panel on Climate Change (IPCC) considers the waste sector a biogenic (i.e., natural) source of carbon dioxide emissions. Since the GHG emissions inventory methodology only covers anthropogenic sources, carbon dioxide from landfills is not tracked. Nitrogen oxides, carbon monoxide and nitrous oxides from landfills are produced in smaller amounts compared to methane, and therefore were excluded from this report.

The methodology for calculating and reporting direct methane emissions from FLW in each of the three North American countries is based on the IPCC guidelines. These guidelines are used by each of the federal governments to report GHG emissions inventories to the United Nations Framework Convention on Climate Change. More details on the IPCC model can be found in Appendix 4; they originate in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Chapter 3: Solid Waste Disposal (Pipatti and Svardal 2006). These methodologies only cover direct GHG emissions from landfill, compost and incineration. Embedded GHG emissions throughout the food supply chain associated with FLW are not covered.

Another approach for estimating GHG emissions is a life-cycle analysis, which covers emissions from activities associated with the life-cycle of food (e.g., production stages, through to waste management); some analyses omit GHG emissions from portions of the food supply chain.

Available methodologies for GHG emissions quantification, in each country, are described in the sections below, and summarized in TABLE 38. Unless noted otherwise, the methodologies include direct methane emissions from landfilling and do not include GHG emissions from upstream sources or other waste management activities.

TABLE 38. Existing Methodologies for Quantification of Greenhouse Gas

Country	Methodology	Description*
Canada	National inventory (Environment and Climate Change Canada 2016)	National GHG inventory using self-reported data and a first-order decay model using IPCC guidelines.
	Landfill gas generation estimation tool (British Columbia Ministry of Environment 2017)	Landfill gas estimation spreadsheet tool using a first-order decay model, for use of individual facility operators to estimate and report methane emissions.
	GHG calculator (ICF Consulting 2005)	Adaptation using Canada-specific emission factors of the WaRM tool from the United States; scope includes GHG emissions from waste management activities (e.g., transportation, facility operation, methane emissions) and not upstream emissions.
Mexico	National inventory (INECC 2016)	Estimations of GHG emissions, using IPCC guidelines and country-specific emission factors.
	Landfill gas model (Stage and Davila 2009)	Spreadsheet model for estimating landfill gas generation at individual facilities; developed by the Global Methane Initiative.
	Estimations based on United States emission factors (Bergua et al. 2016)	Estimations of landfill gas generation from organic waste, using emission factors from the United States.
United States	National inventory (US EPA 2017a)	National GHG inventory using self-reported data and a first-order decay model using IPCC guidelines.
	Landfill gas model (US EPA 2005)	Spreadsheet tool using a first-order decay model to estimate landfill gas emissions for individual facilities.
	WaRM tool (US EPA 2015a)	Life-cycle GHG calculator using GHG emissions specific to waste management scenarios; scope includes GHG emissions from waste management activities (e.g., transportation, facility operation, methane emissions) and upstream emissions from food production (pre-harvest and post-harvest), processing and distribution but not retail, foodservice and consumption.

* The methodologies cover direct methane emissions from landfilling and do not cover GHG emissions from upstream sources or other waste management activities unless noted.

6.1.1.1 Canada

Canada has a national GHG inventory that includes GHGs from waste disposal. This inventory uses self-reported data by facilities that emit more than 50 kilotonnes (kt) of carbon dioxide equivalent (CO_2e) per year, in combination with a first-order decay model in accordance with IPCC guidelines. Reporting facilities must use the guidelines set by the IPCC to make their GHG emissions estimates (Environment and Climate Change Canada 2016).

At a provincial level, the British Columbia Ministry of Environment developed a landfill gas generation estimation tool for calculating methane emissions for individual landfills (British Columbia Ministry of Environment 2017). While not specific to FLW, the model is based on the first-order decay of organic matter in a landfill environment and can be used by landfill owners and operators to estimate the methane contribution from FLW at their facility. This model does not estimate life-cycle GHG emissions, only direct methane emissions from landfills.

Environment and Climate Change Canada (2013) has a GHG calculator for waste management, that is based on the Waste Reduction Model (WaRM) from the US EPA but has been adapted to use emission factors more relevant for the conditions in Canada (ICF Consulting 2005). The calculator compares the differences in GHG emissions among different waste-management scenarios. It is a useful tool for decision-making because it has emission factors for FLW according to management practice (composting, anaerobic digestion, combustion, landfilling). This tool is limited to downstream GHG emissions only and does not include upstream emission factors for source reduction of FLW.

6.1.1.2 Mexico

Using the IPCC guidelines, Mexico estimated emissions of methane from waste and included them in its national GHG inventory (INECC 2011, 2016). The emissions estimates were based on the scenario of solid-waste disposal on top of soil, and used country-specific emission factors developed by the National Institute for Ecology and Climate Change (*Instituto Nacional de Ecología y Cambio Climático*—INECC) (INECC 2016). The inventory data are considered the official GHG emissions data in Mexico.

Through the Global Methane Initiative (GMI), a spreadsheet was developed for Mexico (Stage and Davila 2009) for a landfill gas model similar to the IPCC model that estimates GHG emissions based on climate conditions, quantity of waste, waste composition, and infrastructure for landfill gas capture. This model is meant for use at individual landfills, and not for estimating landfill gas emissions nationally.

Another methodology for estimating GHG emissions from landfills is from a draft white paper published for GMI (Bergua et al. 2016). Emission factors from the US EPA's Landfill Gas to Energy Project Development Handbook were used to estimate the methane emissions from landfilled organic material in Mexico (Bergua et al. 2016). This report only includes the methane emissions from landfills and excludes the methane emissions from controlled and uncontrolled dump sites (Bergua et al. 2016).

6.1.1.3 United States

The US EPA tracks national GHG emissions as part of the national emissions inventory (US EPA 2017a). For the waste sector, emissions are estimated from a combination of self-reported data from facilities and a first-order decay model in accordance with IPCC guidelines.

For individual landfills, EPA developed a Landfill Gas Emissions Model (LandGEM) tool that estimates emissions of methane, carbon dioxide, non-methane organic compounds and individual air pollutants, from municipal solid waste (MSW) landfills (US EPA 2005, ii). This spreadsheet tool allows users to select default emission factors or input site-specific values. The model uses a first-order decay equation to estimate methane gas emissions from organic material (including FLW) in landfills

(US EPA 2005, 18). For carbon dioxide, emissions are based on the amount of methane produced, as carbon dioxide production is directly affected by methane production (US EPA 2005, 18). Decay equations are not used for all other compounds, which are often found in trace quantities; rather, emissions estimates are based on concentrations of the compounds found in landfill gas (US EPA 2005, 19).

EPA also developed the WaRM tool, a model that calculates and compares life-cycle GHG emissions and offsets of waste-management scenarios (US EPA 2015a, 1–3). The WaRM tool has added materials and management practices since its creation almost 20 years ago, the most recent being for anaerobic digestion of organic materials, in 2014. The WaRM tool compares the GHG emissions and offsets for specific material types for their life-cycle (excluding use and consumption) when managed through source reduction, recycling, composting, anaerobic digestion, combustion or landfilling (US EPA 2015a, 1–10).

Using the WaRM tool, source reduction emissions include the equivalent GHG emissions generated from growing (e.g., land use and inputs), harvesting, transporting, processing and distributing food. It does not include emissions from product use (retail and foodservice) and consumer stages of the food supply chain. Despite the product-use gap, WaRM is the best available tool for quantifying life-cycle GHG emissions, as other tools only quantify downstream emissions. Overall, WaRM is useful for decision-making—for instance, using the net GHG emissions savings to pursue or demonstrate the value of FLW reduction or recovery programs. WaRM is especially valuable when combined with the GHG equivalencies calculator, a tool that translates GHG emissions into tangible equivalencies such as annual emissions from cars, or household energy use (US EPA 2017b).

6.1.2 Impact of Greenhouse Gas from Food Loss and Waste

This section provides an estimate of the quantity of FLW (edible and inedible parts of food) currently disposed of in landfills, by country, based on available data. Due to the different approaches to quantifying GHG emissions (Section 6.1.1), the results in this section are presented in two ways:

- **methane emissions** from FLW degrading under anaerobic conditions in a landfill, calculated using an inventory approach; and
- **life-cycle GHG emissions** from upstream (food production, processing, distribution) and downstream (waste collection, transport, operations, and degradation). The calculations capture most of the life-cycle of food, but exclude the retail, foodservice and consumption stages as well as forms of FLW waste management other than disposal (e.g., combustion, composting, anaerobic digestion). They account for embedded GHG emissions in addition to direct methane emissions.

6.1.2.1 Methane Emissions

To maintain consistency among the three countries, the IPCC waste model—the globally accepted standard—was used to estimate generation of methane gas. The model was adapted to use country-specific emission factors, where available, and otherwise to use default regional values set by the IPCC. A detailed list of assumptions and input parameters used in the IPCC waste model, for each country, is provided in Appendix 4.1.

6.1.2.2 Life-Cycle GHG Emissions

In North America, the WaRM tool (Section 6.1.1.3) is the best available life-cycle GHG emissions calculator that includes both upstream and downstream emissions from FLW. Upstream emissions include those from food production (pre-harvest and post-harvest), processing and distribution, but not retail, foodservice and consumption. In the scope of this report, only emissions from landfilled FLW are included for downstream emissions. Another tool developed in the United States—the Solid Waste Decision Support Tool (MSW DST)—evaluates the cost and environmental aspects associated with waste management strategies. The MSW DST does not quantify emissions for FLW; rather, it produces economic values for different waste management strategies (Research Triangle Institute International 2012).

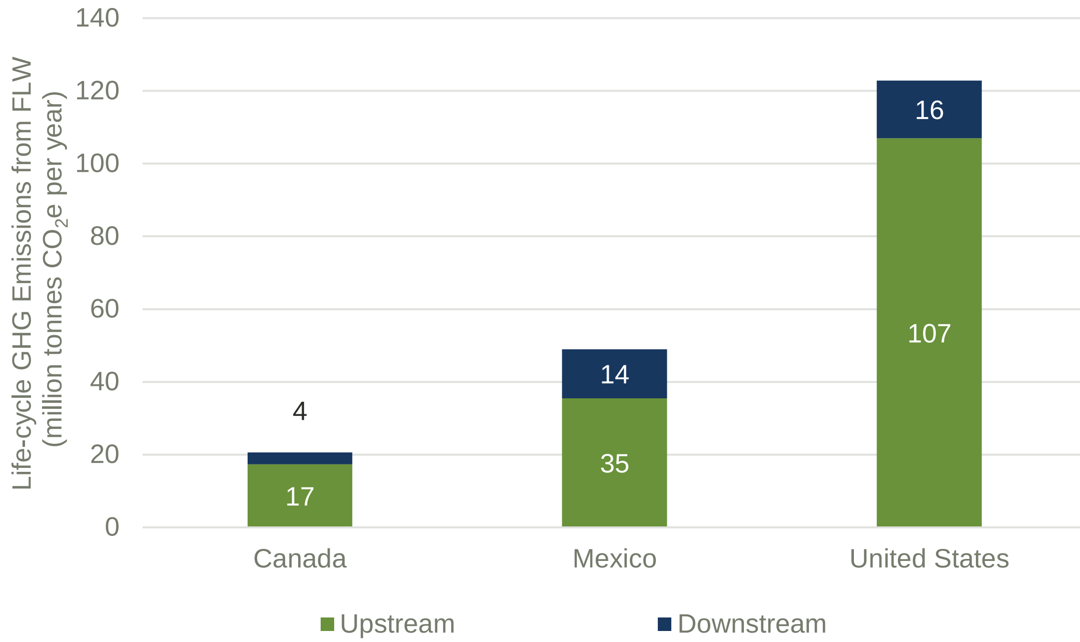
The GHG calculator in Canada is based on WaRM, with adjustments for Canada-specific factors that include downstream emissions from FLW but do not include source reduction (Section 6.1.1.1). Therefore, for Canada, the research team used the United States–based WaRM tool for upstream emissions and the Canadian GHG calculator for downstream emissions.

For the United States and Mexico, the research team used the WaRM tool for upstream and downstream emissions. Where possible, model assumptions were adjusted in the WaRM tool to better reflect the conditions in Mexico, such as climatic conditions and landfill gas recovery rates. Assumptions and inputs for the life-cycle GHG emissions estimates are provided in Appendix 4. The appendix only includes the assumptions and inputs to the spreadsheet calculator tool. Underlying assumptions of the tool, limitations and formulas are provided in the US EPA's WaRM documentation (US EPA 2015a) and IPCC's National Greenhouse Gas Inventories documentation (Pipatti and Svardal 2006).

Outputs may not accurately reflect the situation in Canada and Mexico, as the WaRM tool was developed for conditions in the United States. Furthermore, the WaRM tool does not include emissions from use (retail and foodservice) and consumption, so the actual emissions of FLW are even higher. Nonetheless, the WaRM tool is the best available calculator to estimate life-cycle GHG emissions from FLW.

FIGURE 10 presents the life-cycle GHG emissions associated with landfilled FLW, by country. Upstream emissions contribute to more than 80% of estimated life-cycle GHG emissions from FLW. The life-cycle GHG emissions estimated for North America is 193 million tonnes CO_2e per year, equivalent to 41 million cars driven for a year (based on average car use in the United States). The upstream emissions are 159 million tonnes CO_2e per year, equivalent to 34 million cars driven for a year. These estimates are underestimates of the actual GHG emissions as they only include landfilled FLW and exclude food consumption. Nonetheless, these results demonstrate the importance of considering the actual embedded GHG emissions occurring throughout the entire food supply chain (production, distribution, retail and consumption), such as the emissions from agricultural activities, transportation and refrigeration (Venkat 2011).

FIGURE 10. Life-Cycle Greenhouse Gas Emissions from Landfilled Food Loss and Waste



Note: Data for the calculations were not always available for the same year (e.g., tonnages and emission factors are from different reference years). Life-cycle GHG emissions were calculated for landfilled FLW, both food and inedible parts; and for food production (pre-harvest and post-harvest), processing and distribution. Retail, foodservice and consumption are excluded. Outputs may not accurately reflect the situation in Canada and Mexico, as the WaRM tool was developed for use in the United States. Assumptions and inputs for the life-cycle GHG emissions estimates are provided in Appendix 4. CO_2e = carbon dioxide equivalent.

TABLE 39 presents a summary of the estimated direct methane emissions of landfilled FLW. The net methane gas generated from FLW does not increase proportionally with FLW quantities, as each country has a different level of landfill gas capture. For example, the average level of landfill gas capture is lower in Canada than in the United States. Although the Canadian climate is colder, on average, the lower capture rate results in a higher per-unit rate of methane generation. Supplementary information about landfill gas capture, by country, is presented in Appendix 5. In Table 39, estimated life-cycle GHG emissions associated with landfilled FLW are also presented.

TABLE 39. Estimates of Landfilled Food Loss and Waste and Associated Methane Gas Generation and Life-Cycle Greenhouse Gas Emissions, by Country

Country	Data Source Year(s)[1]	FLW Sent to Landfill (million tonnes/ year)	Methane Emissions[2]		Life-Cycle GHG Emissions[2]	
			Net Generation (million tonnes/ year)	Equivalent Generation Rate (tonnes methane/ tonne FLW)	Net Generation (million tonnes CO_2e/ year)	Equivalent Generation Rate (tonnes CO_2e/ tonne FLW)
Canada[3,4]	2009–2015	4.3	0.15	0.036	21	4.83
Mexico[3,4]	2009–2015	8.8	0.44	0.050	49	5.55
United States[4]	2014	26.6	0.64	0.024	123	4.62
Total	-	**39.7**	**1.23**	-	**193**	-
Average	-	-	-	**0.031**	-	**4.90**

[1] Data for the calculations were not always available for the same year (e.g., tonnages and emission factors are from different reference years).
[2] Methane and life-cycle GHG emissions were calculated for landfilled FLW, both food and inedible parts; and for food production (pre-harvest and post-harvest), processing and distribution. Retail, foodservice and consumption are excluded. Net generation is the net amount of methane or life-cycle GHGs, with recovered landfill gases subtracted out. The equivalent generation rate is the equivalent quantity of methane or life-cycle GHGs emitted per tonne of FLW.
[3] Outputs may not accurately reflect the situations in Canada and Mexico, as the WaRM tool was developed for use in the United States.
[4] Assumptions and inputs for GHG emissions estimates are provided in Appendix 4.

6.1.3 Potential Methane and Greenhouse Gas Reduction from Reduction of Food Loss and Waste, and Food Rescue and Recovery

This section provides estimates, for each North American country, of the potential amounts of methane gas emissions from landfilled FLW that could be eliminated through source reduction, and rescue and recovery; along with potential reductions in associated life-cycle GHG emissions.

The methodology for estimating the potential reduction in methane gas emissions from landfills was based on the IPCC method (see Appendix 4, Section A4.1), with landfill gas capture subtracted from the total potential methane that could be generated from FLW in landfills. The potential reduction in life-cycle GHG emissions was calculated based on the WaRM tool (Section 6.1.1). Assumptions and inputs to the WaRM tool were the same as those in Section 6.1.2, with inputs adjusted as shown in Table A4-3, in Appendix 4, Section A4.2. Inputs for scenario calculations are in Appendix 4, Section A4.3.

The three scenarios analyzed in this section are as follows:

- **High Implementation:** Assumes that for the stages of the food supply chain included in this report, each country achieves the **50% FLW reduction** target at the retail (including foodservice) and consumer levels, set in Sustainable Development Goal 12.3 and in the US national food loss and waste reduction goal. Assumes a 50% FLW reduction target is attained in the processing and distribution stages of the food supply chain.

- **Limited Implementation:** Assumes that for the stages of the food supply chain included in this report, each country achieves **20% FLW reduction,** based on the 20% reduction target in the Rethink Food Waste through Economics and Data report (ReFED 2016) for the United States.
- **Status Quo:** Assumes no **(0%)** changes to the amount of FLW going to landfill; methane emissions and life-cycle GHG emissions remain unchanged (Section 6.1.2).

Assumptions for the three scenarios are conservative estimates of FLW reduction because strategies targeted at the post-harvest to retail/foodservice stages can also affect the agricultural production pre-harvest and consumer stages of the food supply.

The quantities of FLW assumed for each of the FLW avoidance scenarios are presented in TABLE 40.

TABLE 40. Quantities in Avoidance Scenarios for Food Loss and Waste

Baseline or Scenario	Canada (million tonnes/year)	Mexico (million tonnes/year)	United States (million tonnes/year)
Total Baseline/Status Quo FLW	13.1	28.4	126.0
Baseline in Post-Harvest/Distribution/Retail/Foodservice	3.7	14.7	33.2
Baseline Edible in Post-Harvest/ Distribution/Retail/Foodservice	3.2	12.7	29.5
FLW Avoided from Landfill Disposal for High Implementation (50% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice)	1.6	6.3	14.7
FLW Avoided from Landfill Disposal for Limited Implementation (20% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice)	0.6	2.5	5.9
FLW Avoided from Landfill Disposal for Status Quo (0% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice)	0	0	0

Note: Derived from baseline FLW estimates provided in TABLE 7.

The methane and life-cycle GHG emissions are presented in TABLE 41, first by country and then with all North American countries combined; the calculations methodology is presented in Appendix 4.

TABLE 41. **Avoidance Scenarios for Landfilled Food Loss and Waste**

Scenario	Avoided FLW to Landfill Disposal (million tonnes)[1,2]	Net Methane Gas Avoided (million tonnes/ year)[2,3]	Equivalent Methane Gas Avoidance Rate (tonnes methane/ tonne FLW)	Life-Cycle GHG Emissions Avoided (million tonnes CO_2e/ year)[3]	Equivalent Life-Cycle GHG Emissions Avoidance Rate (tonnes CO_2e/ tonne FLW)
Canada[4,5]					
High Implementation	1.6	0.06	0.036	7.7	4.83
Limited Implementation	0.6	0.02	0.036	3.1	4.83
Status Quo	0	0	0.036	0	4.83
Mexico[4,5]					
High Implementation	6.3	0.32	0.050	35.3	5.55
Limited Implementation	2.5	0.13	0.050	14.1	5.55
Status Quo	0	0	0.050	0	5.55
United States[5]					
High Implementation	14.7	0.35	0.024	68.1	4.62
Limited Implementation	5.9	0.14	0.024	27.3	4.62
Status Quo	0	0	0.024	0	4.62
North America[5,6]					
High Implementation	22.7	0.73	0.031[7]	111.1	4.90[7]
Limited Implementation	9.1	0.29	0.031[7]	44.4	4.90[7]
Status Quo	0	0	0.031[7]	0	4.90[7]

[1] Data for the calculations were not always available for the same year (e.g., tonnages and emission factors are from different reference years).
[2] Landfill gas capture already subtracted from the total.
[3] Methane and life-cycle GHG emissions calculated for landfilled FLW, both edible and inedible food.
[4] Outputs may not accurately reflect the situation in Canada and Mexico, as the WaRM tool was developed in the United States.
[5] Assumptions and inputs for the life-cycle GHG emissions estimates are provided in Appendix 4.
[6] Sum of each country may not add up to North American total due to rounding of numbers for presentation.
[7] North American average.

6.2 Other Environmental and Socio-Economic Impacts

Quantification of other environmental and socio-economic impacts depends heavily on accurate quantification of FLW. Because detailed and accurate quantification of FLW (Section 5) is still in the early stages of development, the degree of certainty associated with these findings is unknown. This section presents the existing quantification methodologies (Section 6.2.1) for environmental and socio-economic impacts, followed by summaries of environmental (Section 6.2.2) and socio-economic impacts (Section 6.2.3) of FLW in North America.

6.2.1 Quantification Methodologies

Several studies have quantified and monetized the global environmental impact of FLW (FAO 2013; FAO 2014; Kummu et al. 2012; Schwegler 2014). These studies make up the primary sources of information for the environmental and socio-economic impacts presented in this report. A list of the studies is provided below. A summary of the methodologies is provided in Appendix 6.

- *Food Wastage Footprint: Impacts on Natural Resources* (FAO 2013)
- *Food Wastage Footprint: Full-Cost Accounting* (FAO 2014)
- *Lost Food, Wasted Resources: Global Food Supply Chain Losses and Their Impacts on Freshwater, Cropland, and Fertilizer Use* (Kummu et al. 2012)
- Economic valuation of environmental costs of soil erosion and the loss of biodiversity and ecosystem services caused by food wastage (Schwegler 2014)

In addition to the above, a 2017 report conducted on behalf of Champions 12.3 was used as an information source for this report. *The Business Case For Reducing Food Loss and Waste* “analyzes the financial impacts of historical food loss and waste reduction efforts conducted by a country, a city, and numerous companies” (Hanson and Mitchell 2017).

The following subsections present existing quantification methodologies for each country. Limited data exist on the environmental and socio-economic impacts of FLW specific to each North American country because most studies are global in scope; some group countries together by region while others are only applicable to a single country. For example, the Food and Agriculture Organization (FAO) categorizes United States, Canada, Australia and New Zealand as North America and Oceania region (Gustavsson et al. 2011). Mexico is grouped with Latin America, which combines the Caribbean region, Central America and South America. When country-specific information was not available, regional or global data were extrapolated to provide a basic description of the environmental and socio-economic impact of FLW in each of the North American countries.

6.2.1.1 Canada

Several economic studies in Canada have quantified the economic cost of FLW (Gooch et al. 2010; Abdulla et al. 2013; Gooch et al. 2014). However, studies that quantify environmental and other socio-economic impacts of FLW are not available. A list of the economic studies available for Canada is provided below. A summary of the methodologies is provided in Appendix 6.

- *Food Waste in Canada* (Gooch et al. 2010)
- *$27 Billion Revisited: The Cost of Canada’s Annual Food Waste* (Gooch et al. 2014)
- *The Importance of Quantifying Food Waste in Canada* (Abdulla et al. 2013)

6.2.1.2 Mexico

An as yet unpublished study that was conducted in Mexico by the World Bank (Aguilar Gutiérrez 2016) quantified the economic value of FLW by conducting a market valuation of 79 food products common in the Mexican diet, and estimating the amount of each wasted and the associated economic value. However, aside from the World Bank study, studies that quantify environmental and other socio-economic impacts of FLW are not available.

6.2.1.3 United States

Several studies have quantified the environmental and socio-economic impact of FLW in the United States. A list of the studies is provided below. A summary of the methodologies is provided in Appendix 6.

- *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States* (Buzby et al. 2014)
- *The Progressive Increase of Food Waste in America and Its Environmental Impact* (Hall et al. 2009)
- *A Roadmap to Reduce US Food Waste by 20 Percent* (ReFED 2016)
- *Food Waste Across the Supply Chain: A U.S. Perspective on a Global Problem.* (Toth and Dou 2016)
- The Climate Change and Economic Impacts of Food Waste in the United States (Venkat 2011)

6.2.2 Other Environmental Impacts

TABLE 42 presents a summary of environmental impacts of FLW for each country, including water use, wasted cropland, fertilizer use, biodiversity loss, energy use and wasted landfill space. Each of these environmental impacts is further described in the following subsections. Where North America–specific information was not available, global data are presented. Sources of data are described in the following subsections. Inputs for calculations are provided in Appendix 6.

TABLE 42. Other Environmental Impacts of Food Loss and Waste

Environmental Impact Category[1]	Unit	Canada	Mexico	United States	North America
Water Use[3, a]	billion m^3 per year	1.5	2.7	13.4	17.6
Wasted Cropland[3, a]	million ha per year	1.8	4.4	15.9	22.1
Fertilizer Use[3, a]	million tonnes per year	0.33	0.63	2.97	3.94
Biodiversity Loss[3, b]	loss equivalent to X million US$ per year	26	64	229	319
Energy Use[3, c]	10^{18} Joules per year	1.0	3.4	8.9	13.3
Wasted Landfill Space[2, d]	million m^3 per year	4.2	8.6	25.9	38.6
FLW Tipping Fees[2, d]	million US$ per year	326	249	1,293	1,867

[1] Assumptions and parameters for quantifying environmental and socio-economic impacts are provided in Appendices 4 and 6.
[2] Life-cycle greenhouse gas emissions, wasted landfill space and wasted tipping fees were only calculated for landfilled FLW; the estimates exclude FLW disposed of, unharvested, or lost by other means.
[3] While not explicitly stated in each methodology, estimates assume FLW from all stages of the food supply chain are included. Estimates shown only include the direct cost (market value) of FLW. Indirect costs such as labor, transportation, storage and wasted resources are not included.
Note: m^3 = cubic meters; ha = hectare; kcal = kilocalories.

Sources:
a. Kummu et al. 2012.
b. FAO 2014.
c. Cuellar and Webber 2010.
d. Green Power, Inc. 2014; EPA Victoria 2016.

6.2.2.1 Water Use

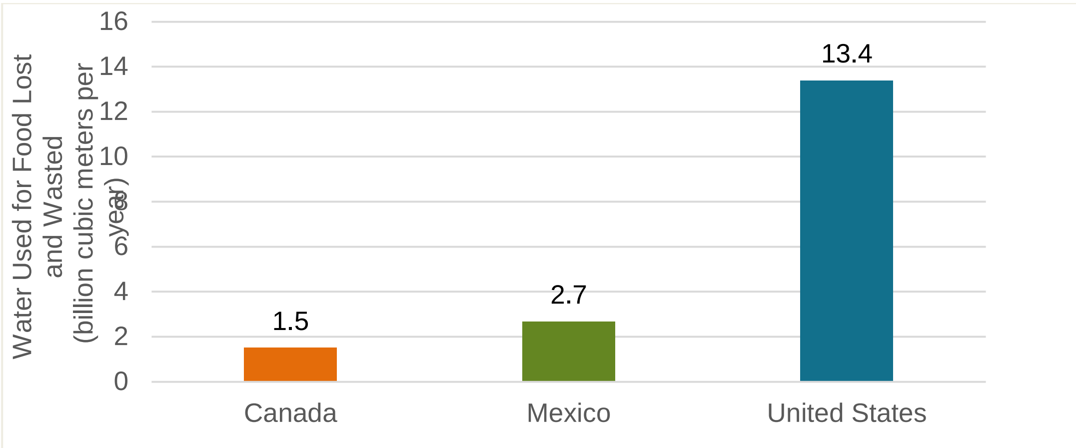
Globally, the agricultural sector is responsible for 70% of global freshwater withdrawals and 90% of consumptive water uses (Hall et al. 2009; Hoekstra et al. 2011; Kummu et al. 2012). Other stages of the food supply chain also use water, but only agricultural water use is included in this calculation. An estimated 173 billion cubic meters (m^3) of water consumption (27% of total water use for agricultural production) are associated with FLW globally across the food supply chain (Lipinski et al. 2013; Kummu et al. 2012). This is equivalent to an average water footprint of 133 million m^3 per tonne of FLW.

Kummu et al. (2012) made estimates per capita, by region (using the same country groupings as does the FAO), of the amount of water used for food that is lost and wasted. These per-capita estimates (presented in FIGURE 11) were applied to each country's population to calculate the water use associated with FLW:

- Canada and the United States (North America and Oceania): 42 m^3/year, per capita.
- Mexico (Latin America): 22 m^3/year, per capita.

In North America, the estimated water footprint of FLW is 17.6 billion m^3 per year, equivalent to filling seven million Olympic-sized swimming pools.

FIGURE 11. Water Used for Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

Source: Based on per-capita wastage of water from growing of food that is lost and wasted, by country region, from Kummu 2012.

6.2.2.2 Wasted Cropland

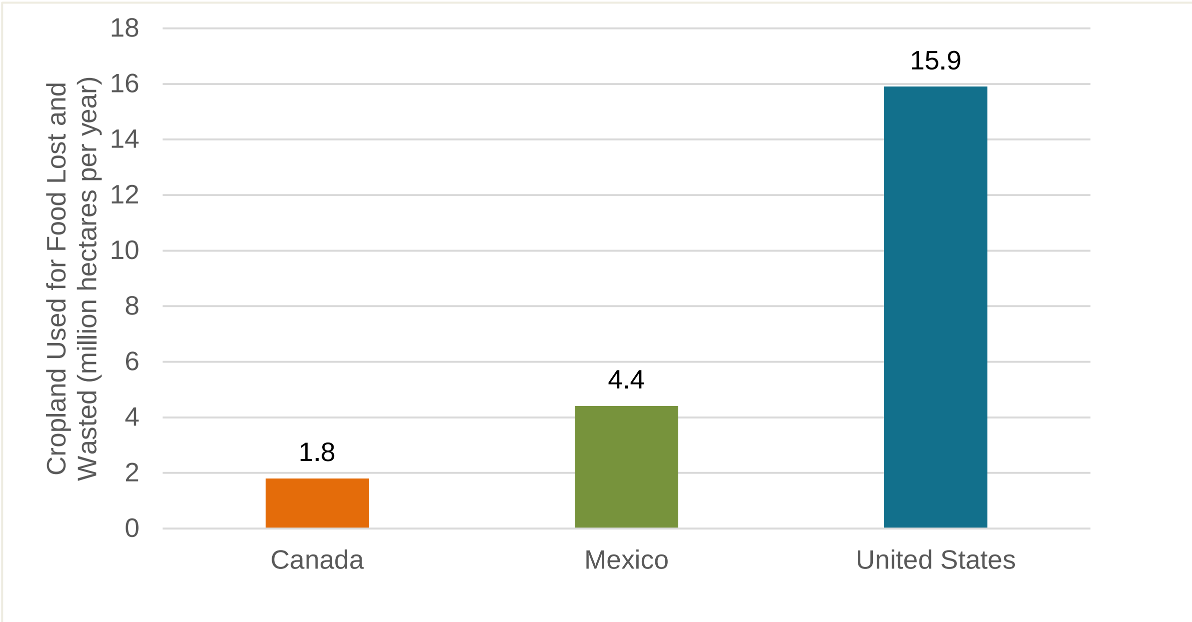
Globally, approximately a total of 1.4 billion hectares of land, representing close to 30 percent of the world's agricultural land area (including both arable and non-arable land) produces food that is wasted (FAO 2013). Close to 80 percent of this land is used for the production of meat and milk, of which most (approximately 85 percent) is non-arable land. When considering only the arable land used (i.e., cropland), the food produced from a total of 198 million hectares per year is lost and wasted (Lipinski et al. 2013; Kummu et al. 2012).

Kummu et al. (2012) made estimates per capita, by region (using the same country groupings as does the FAO), of the amount of cropland used for food that is lost and wasted. These per-capita estimates (presented in FIGURE 12) were applied to each country's population to calculate the wasted cropland associated with FLW:

- Canada and the United States (North America and Oceania): 498 m^2/year, per capita.
- Mexico (Latin America): 361 m^2/year, per capita.

In North America, the estimated amount of cropland used for food that is lost and wasted is 22.1 million hectares per year, equivalent to the size of the state of Utah in the United States.

FIGURE 12. Cropland Used for Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

Source: Based on per-capita wastage of cropland due to food lost and wasted, by country region, from Kummu 2012.

6.2.2.3 Fertilizer Use

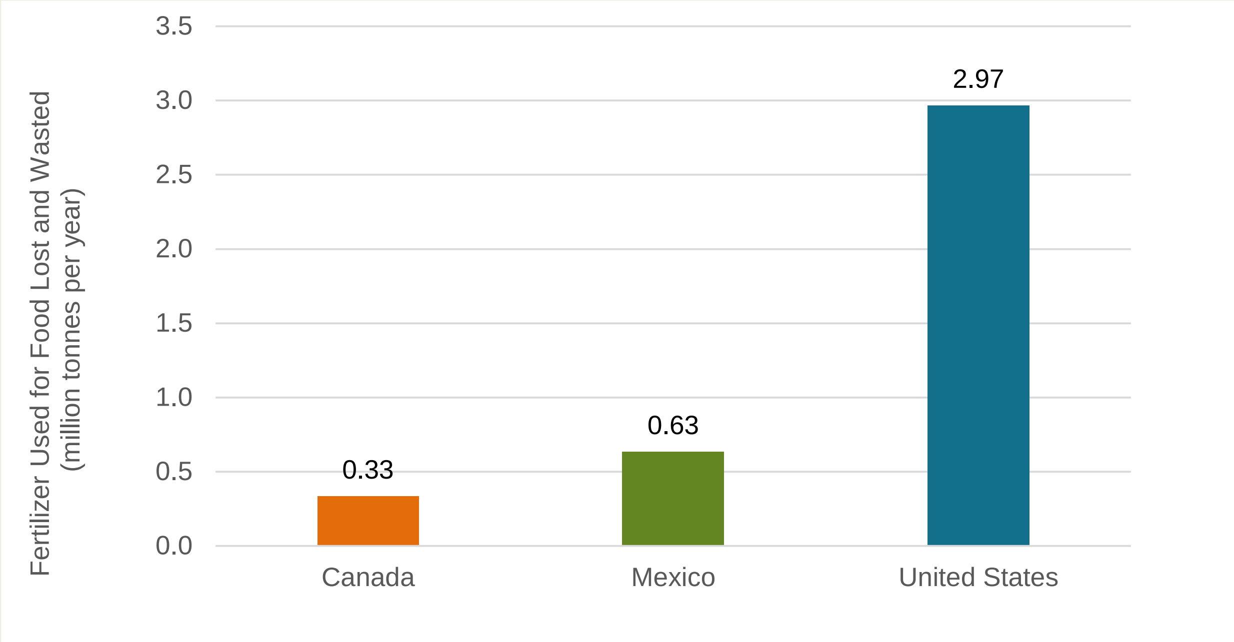
Food production typically requires synthetic fertilizers, which are a major source of GHG emissions due to their energy intensity, emissions of N_2O during the manufacturing of nitrate fertilizers, and use of non-renewable resources such as phosphorus (Vermeulen et al. 2012). The use of fertilizers also causes negative environmental impacts, which are further described in Section 6.2.2.4. Globally, approximately 25 million tonnes of fertilizer are used to grow food that is lost and wasted (Lipinski et al. 2013; Kummu et al. 2012).

Kummu et al. (2012) made estimates, per capita, by region (using the same country groupings as did the FAO), of the amount of fertilizer used for food that is lost and wasted. These per-capita estimates (presented in FIGURE 13) were applied to each country's population to calculate the amount of wasted fertilizer used to grow uneaten food:

- Canada and the United States (North America and Oceania): 9.3 kilograms/year, per capita.
- Mexico (Latin America): 5.2 kilograms/year, per capita.

In North America, the estimated amount of fertilizer used for on food that is lost and wasted is 3.94 million tonnes per year, enough to cover arable land equivalent to the size of the state of Chihuahua.

FIGURE 13. Fertilizer Used for Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

Source: Based on per-capita wastage of fertilizer on food that is lost and wasted, by country region, from Kummu 2012.

6.2.2.4 Biodiversity Loss

Agricultural production is the primary activity that contributes to biodiversity loss, due to the damage it does to natural habitats (FAO 2013; Selman and Greehalg 2009). Examples of how agricultural activities damage habitats and decrease biodiversity include:

- using industrial agriculture practices (e.g., monocropping) which reduce farmland diversity;
- spreading fertilizers and pesticides that generate agricultural run-off and adversely affect water quality, creating “dead zones” in water bodies;
- converting natural land to pastures and producing forage for animal husbandry; and
- destroying marine sea-floor habitats, and catching unwanted species during industrial marine fishing.

Although biodiversity loss is an important environmental impact of FLW, global studies have only linked the two through economic valuation, not through the quantity of FLW (FAO 2013; FAO 2014; Schwegler 2014). In a study by Schwegler et al. (2014), the estimated cost of biodiversity loss was approximately US$4.5 billion per year—loss due to pesticides, fertilizers, and changes in land use. In another study conducted by the FAO (2014), the estimated cost of biodiversity loss was US$32 billion per year, a higher figure than that of Schwegler (2014), but the study also included valuation for fisheries overexploitation (US$10 billion) and loss of pollinators (US$15 billion).

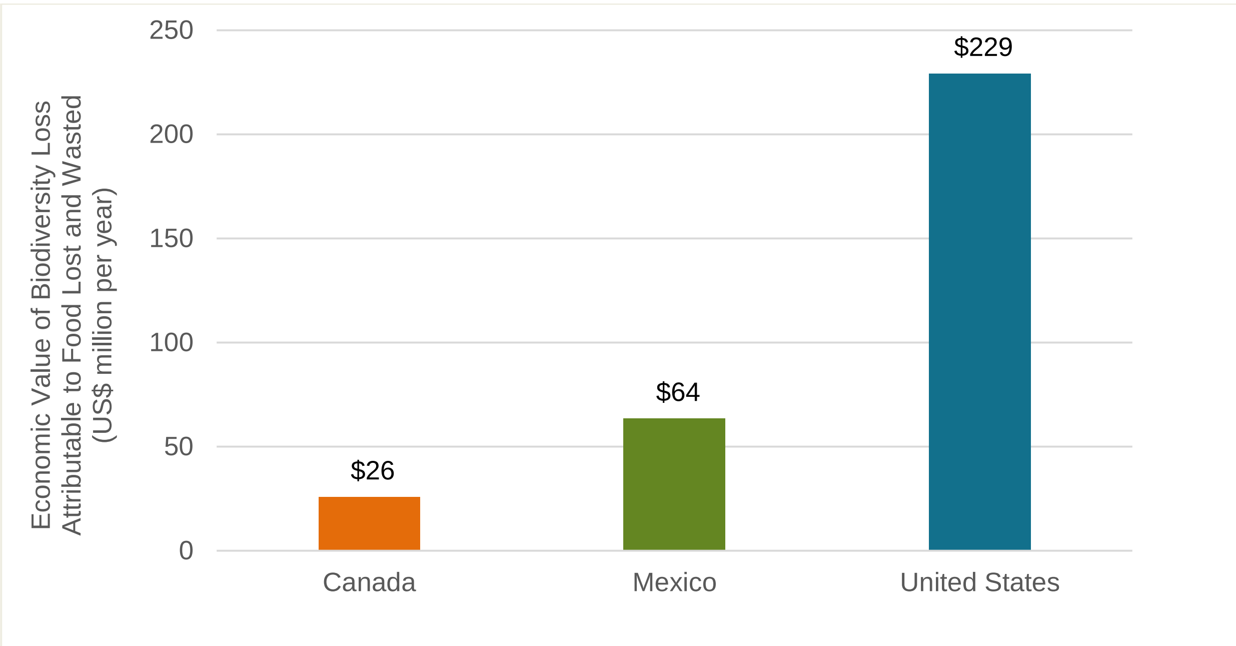
Region-specific indicators for biodiversity loss associated with FLW were not available; therefore, for the purposes of this report, the global unit values from the FAO (2014) were used to estimate the economic cost of biodiversity losses from FLW:

- US$5.46/ha in cropland wasted due to nitrogen eutrophication;

- US$4.75/ha in cropland wasted due to phosphorus eutrophication.
- US$4.21/ha in cropland wasted due to pesticide impacts.

The equivalent economic value of biodiversity loss from food that is grown but never consumed in North America is approximately US$319 million per year. The FAO (2014) did not include unit values for fisheries overexploitation and loss of pollinators, and therefore these two indicators were not included in the calculations for this report. Due to the great range in cost estimates of biodiversity loss and lack of region-specific data, the results presented in FIGURE 14 should be interpreted with caution.

FIGURE 14. Biodiversity Loss Attributable to Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

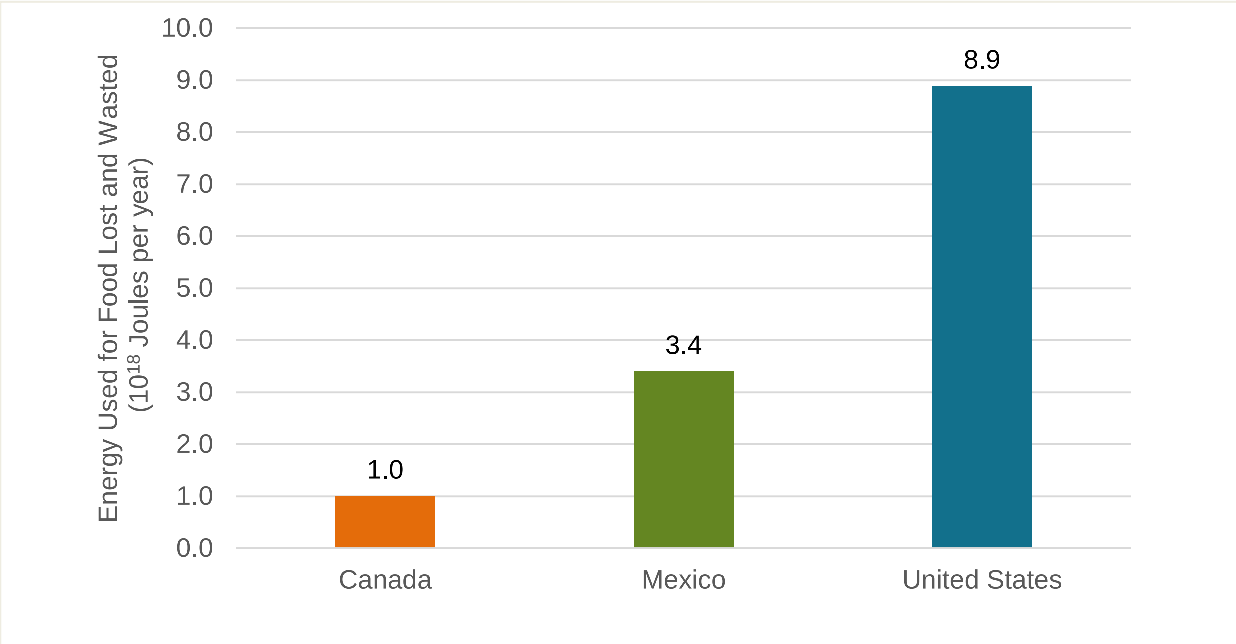
Source: Based on per-hectare dollar values of nitrogen eutrophication, phosphorus eutrophication and pesticide impacts, from FAO (2014), extrapolated for North America based on wasted cropland.

6.2.2.5 Energy Use

Globally, approximately 9.5×10^{19} Joules (J) of energy are used in the food sector (from production stages, to consumption), representing about 30% of global energy consumption (FAO 2011). While an analysis of energy use associated with FLW is not available globally, one study by Cuellar and Webber (2010) quantified the embedded energy of FLW in the United States. This study performed a country-level estimate of the amount of energy required to produce food that was wasted. This study did not, however, include the energy required to package, transport, store, divert and dispose of FLW. Therefore, the actual energy use is expected to be higher. As these were the only data available to link energy use and FLW, the embedded energy of FLW per capita (28 GJ/person/year), from this study, was used to extrapolate to estimates for Canada and Mexico.

FLW contributes to an estimated 1.33×10^{19} J of energy per year in North America, equivalent to powering 274 million homes for a year, or to 2.2 billion barrels of oil. Since the results presented in FIGURE 15 were extrapolated from a single country's data, they should be interpreted with caution.

FIGURE 15. Energy Used for Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

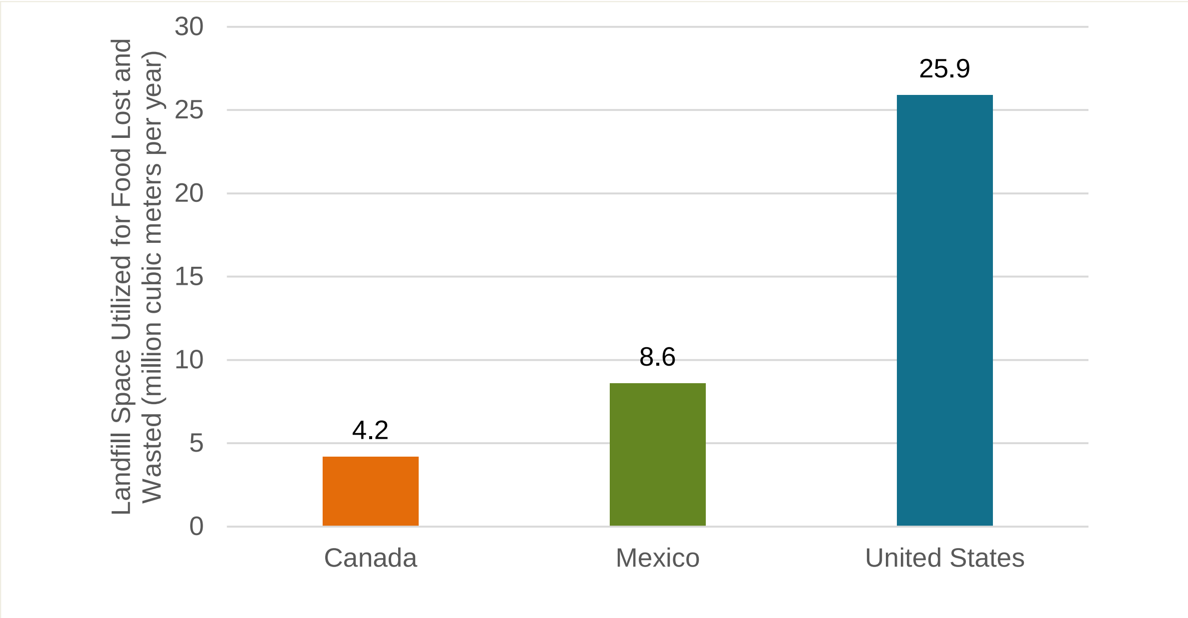
Source: Based on embedded energy in FLW for the United States, from Cuellar and Webber 2010, extrapolated for North America.

6.2.2.6 Wasted Landfill Space

As described in Section 6.1, one of the significant environmental impacts of landfilling FLW is the generation of methane gas. Landfills also generate leachate, which are often a long-term source of soil, groundwater and surface water contamination as leachate formation occurs over decades both during landfill operation and after closure (El-Fadel et al. 1997). The conversion of natural land to a landfilling operation can lead to habitat loss, air pollution, and vegetation damage; it can also attract pests and increase the risk of unwanted animal encounters (El-Fadel et al. 1997). Reducing the use of landfills for the disposal of FLW can mitigate such environmental impacts. Based on the average density of compacted FLW (1,029 kilograms/m^3), approximately 38.6 million cubic meters of landfill space are wasted per year in North America, due to landfilling FLW (Environment Protection Authority Victoria 2016). Landfill space occupied by FLW in each country is displayed in FIGURE 16. The equivalent cost from the tipping fees for landfilling FLW each year in North America is US$1.867 billion, based on average tipping fees in each country. Equivalent tipping fee costs, per country, are displayed in FIGURE 17.

Estimates of national tipping fees were determined based on available statistics, studies and a broad online analysis of current municipal rates[7] (Green Power Inc. 2014).

FIGURE 16. Landfill Space Utilized for Food Lost and Wasted, per Year, in North America

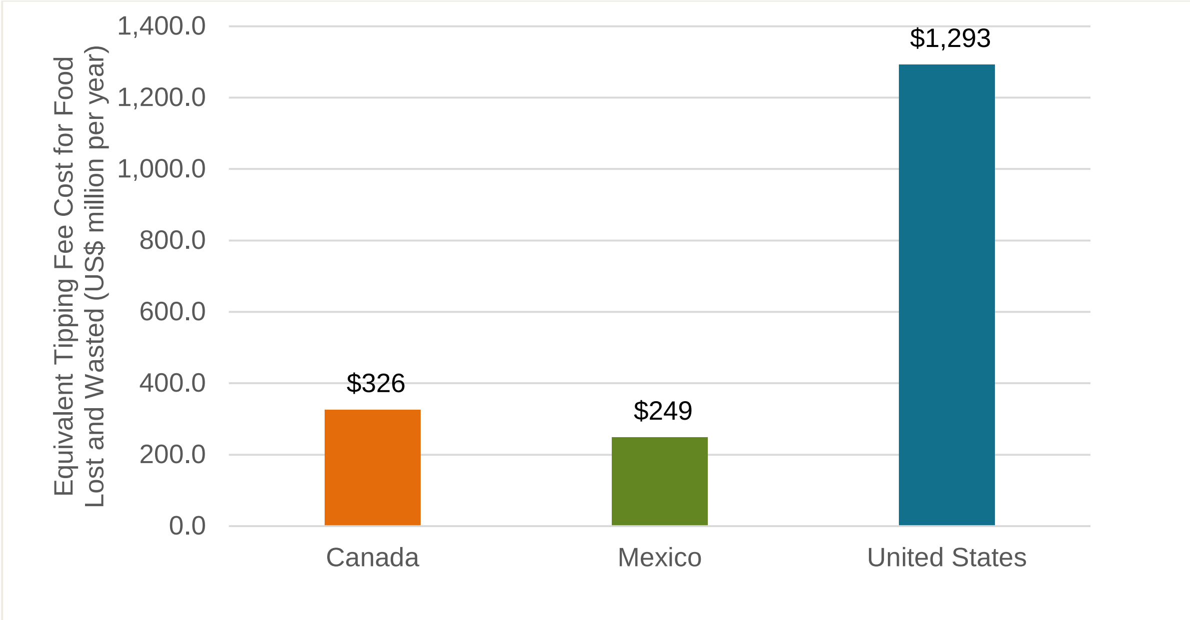


Note: Wasted landfill space was only calculated for landfilled FLW. Excludes FLW disposed of, unharvested or lost by other means.

Source: Based on the average density of compacted FLW, from Environmental Protection Authority Victoria 2016, extrapolated to North America.

[7] The average tipping fee for Canada was determined by surveying the posted tipping fees for 31 municipalities across 10 provinces and three territories.

FIGURE 17. **Equivalent Tipping Fee Costs for Food Lost and Wasted, per Year, in North America**



Note: Wasted tipping fees were only calculated for landfilled FLW. Excludes FLW disposed of, unharvested or lost by other means.

Source: Based on available statistics, studies and analysis of current municipal rates, from Green Power Inc. 2014.

6.2.3 Socio-Economic Impacts

A summary of quantifiable socio-economic impacts from FLW (market value of FLW and wasted calories) is presented in TABLE 43. Each of these socio-economic impacts are further described in the following subsections. Where information specific to North America was not available, global data are presented.

TABLE 43. **Socio-Economic Impacts of Food Loss and Waste**

Socio-Economic Impact Category	Unit	Canada	Mexico	United States	North America
Market Value of FLW	US$ billion per year	24[a]	36[b]	218[c]	278
Wasted Calories [d]	trillion kcal per year	20	20	177	217

Note: While not explicitly stated in each methodology, estimates assume FLW from all stages of the food supply chain are included.

Sources:
a. Gooch et al. 2014.
b. Aguilar Gutiérrez 2016.
c. ReFED 2016.
d. Lipinski et al. 2013.

Some socio-economic impacts of FLW are more challenging to quantify, such as livelihoods, health effects, and conflicts. Global or regional quantifications of these socio-economic impacts, by volume of FLW, are not available. However, one study estimated the equivalent economic value on a global scale, of select socio-economic impacts. The results were as follows (FAO 2014):

- US$333 billion per year in livelihood loss;
- US$145 billion per year in health damages;
- US$8 billion per year in acute health effects of pesticides; and
- US$396 billion per year in risk of conflicts from food shortages.

6.2.3.1 Market Value of FLW

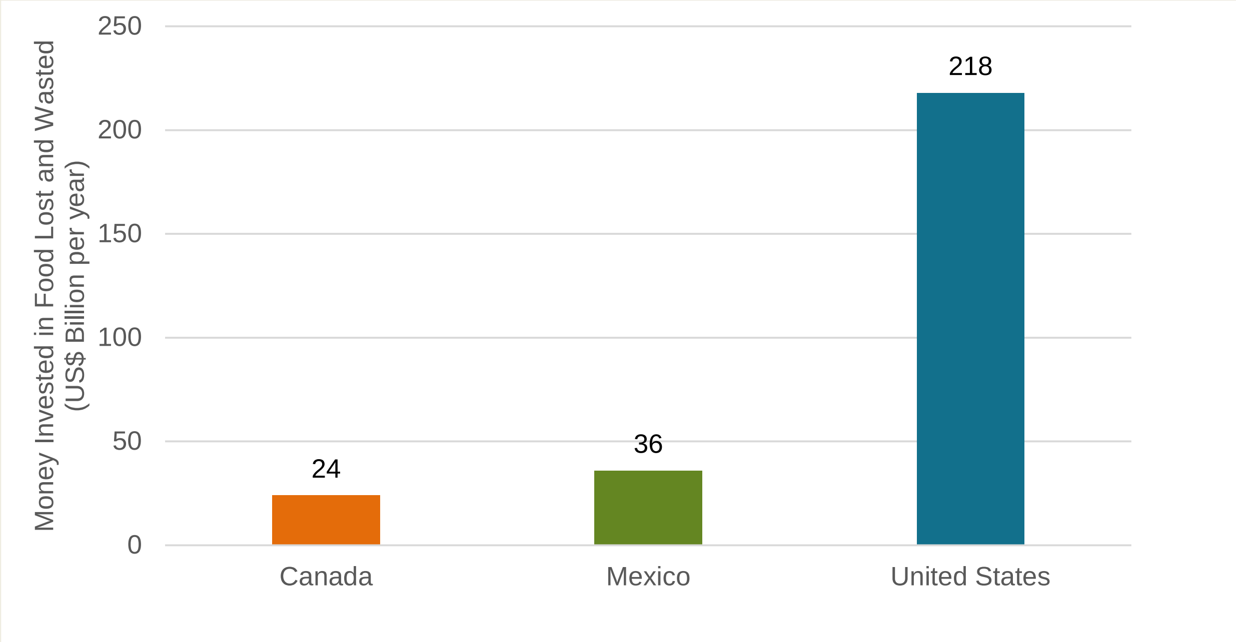
Several studies have quantified the economic value of FLW in the North American countries (Aguilar Gutiérrez 2016; Buzby et al. 2014; Gooch et al. 2014; ReFED 2016; Venkat 2011). These studies quantified economic value of FLW based on direct costs (e.g., market prices) and excluded the indirect costs (such as environmental and social impacts).

In Canada, Gooch et al. (2014) estimated that FLW is equivalent to US$24 billion (C$31 billion) annually. This is a conservative estimate which does not include the waste generated in hospitals, the cruise industry, prisons and other public institutions. Furthermore, this report only evaluated the market value of FLW. The report estimated that the life-cycle cost of FLW would exceed US$70 billion (C$100 billion).

In Mexico, the estimated cost of FLW is equivalent to US$36 million per year (Aguilar Gutiérrez 2016). This number is based on the economic valuation of loss rates of 79 food products common to the Mexican diet. It should account for most of the FLW in the country, but it is still considered a conservative estimate.

Studies in the United States estimated the cost of FLW using various methodologies, resulting in a range of values from US$162 billion to US$218 billion (Venkat 2011; Buzby et al. 2014; ReFED 2016). The most recent study was conducted by ReFED (2016), and evaluated the cost of FLW throughout the supply chain to be US$218 billion; the estimate from this study was used for this report. FIGURE 18 highlights the amount of money invested in food that was produced and never consumed.

FIGURE 18. Money Invested in Food Lost and Wasted, per Year, in North America



Note: While not explicitly stated in each methodology, estimates assume FLW from all stages of the food supply chain are included. Estimates shown only include the direct cost (market value) of FLW. Indirect costs such as labor, transportation, storage and wasted resources are not included.

Sources: Gooch et al. 2014; Aguilar Gutiérrez 2016; ReFED 2016.

6.2.3.2 Wasted Calories

Globally, FLW accounts for approximately 24% of all food calories currently grown across the supply chain, equivalent to $1.5x10^{15}$ kcal per year (Lipinski et al. 2013). Current projections indicate a need to increase global food calories by 60% ($6x10^{15}$ kcal), by 2050, to feed a population of nine billion (Searchinger et al. 2013). Reducing FLW can reduce the food gap without the need for additional resources to produce more food. Although there are some limitations to using calories as a unit of measure for food gaps, since it does not incorporate the nutritional value of food, it is the best available metric compared to economic value (due to changing food prices) or volume (due to water weight and inedible parts).

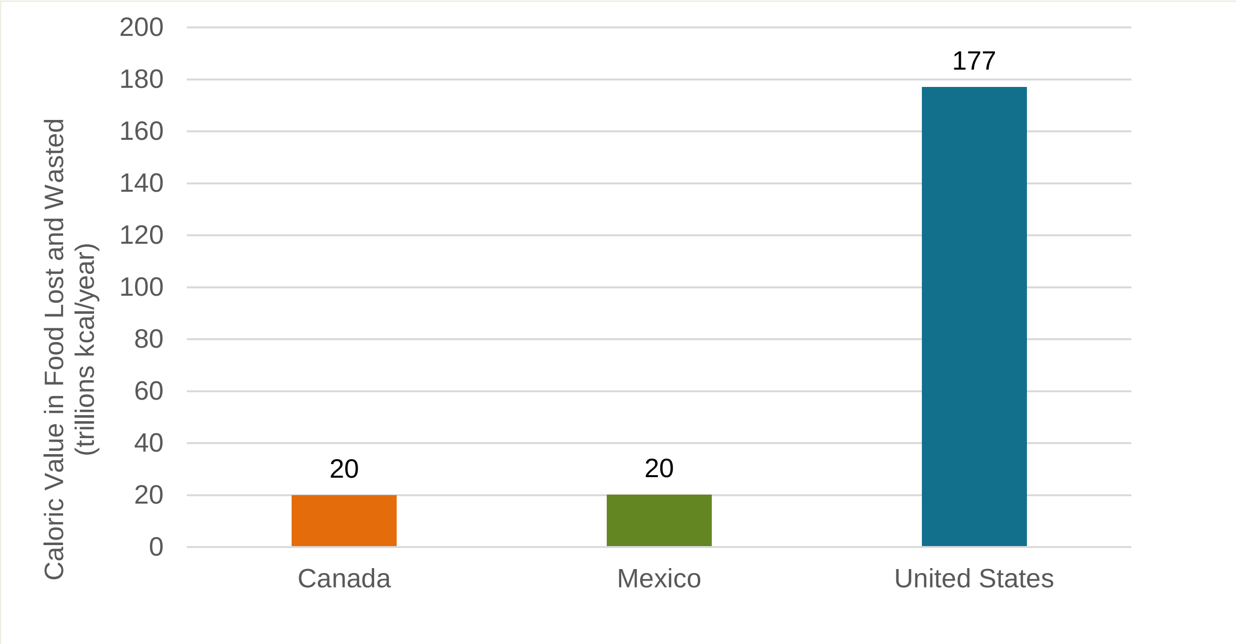
Lipinski et al. (2013) estimated the caloric content of FLW per capita per day, using the same country groupings as does the FAO. These per-capita estimates were applied to each country's population to calculate the wasted calories from FLW:

- Canada and the United States[8] (North America and Oceania): 1,520 kcal/person, per day.
- Mexico (Latin America): 453 kcal/person per day.

[8] One study conducted in the United States estimated the caloric value of FLW to be 1,249 kcal/person, per day (Buzby, et al. 2014). However, it only included the retail and consumer stages of the food supply chain. Therefore, the North America and Oceania estimate that encompassed the entire food supply chain was considered to be more relevant for comparison.

The total amount of wasted calories for each country is displayed in FIGURE 19.

FIGURE 19. **Caloric Value in Food Lost and Wasted Each Year in North America**



Note: While not explicitly stated in the methodology used, estimates assume FLW from all stages of the food supply chain are included.

Source: Based on per-capita kcal lost from FLW, from WRI 2013, for Mexico.

In North America, approximately 72 million people are food-insecure. The current rates of food insecurity, by country, are:

- Canada: 8% of population, equivalent to 3 million people (Statistics Canada 2015);
- Mexico: 23% of population, equivalent to 28 million people (Coneval 2014); and
- United States: 13% of population, equivalent to 41 million people (USDA ERS 2015).

Based on an average caloric requirement of 2,300 kcal/person per day (Searchinger et al. 2013), the caloric value of FLW in North America (217 trillion kcal/year) is enough to feed close to 260 million people per year. When interpreting this high-level analysis, wasted calories may not directly relate to healthy, nutritious food. However, it serves as an approximate benchmark for assessing the quantity of available food for consumption.

7 Opportunities

This report covers the current status, approaches, and policies for source reduction of food loss and waste (FLW), and recovery, measuring, tracking and reporting along the food chain, from the post-harvest through the retail/foodservice stages (Sections 3.4, 3.5, 4.4, 4.5, 5.4 and 5.5). Although a significant amount of food is wasted at the agricultural production pre-harvest and consumer stages of the food supply chain, this report focuses on FLW at the **post-harvest handling and storage, processing, distribution, retail and foodservice** stages. This section provides an overview of opportunities to enhance FLW initiatives in North America.

Opportunities relevant to FLW recycling (e.g., landfill disposal ban on organics) can be found in a companion report published by the Commission for Environmental Cooperation (CEC), entitled *Characterization and Management of Organic Waste in North America*. When combined with these reports, future work to study food supply stages beyond the scope of this report can create an integrated FLW avoidance approach that spans the entire food supply chain.

Regional and country-specific considerations are reviewed in Sections 7.1 and 7.2, respectively, and provide context for the opportunities presented. Cross-cutting opportunities are presented first, in Section 7.3, followed by opportunities specific to reduction, rescue and recovery, and measuring, tracking and reporting, in Sections, 7.4, 7.5 and 7.6, respectively. Each opportunity is accompanied by a brief description, implementation considerations, and stakeholders involved. **All opportunities listed apply to Canada, Mexico and the United States.**

7.1 Regional Considerations

Considerations that apply to all three countries are presented below.

Country-specific Implementation

While the scale, cultural context, economic climate and other factors vary by country, the opportunities listed are applicable to each country. The implementing stakeholders (e.g., government department; industrial, commercial and institutional [ICI] sector; or nongovernmental organization [NGO]) and specific programs applicable to each opportunity vary by country. The opportunities are framed broadly enough that each country can customize its implementation plans to factor in country-specific variations such as geography, demographics, government priorities, available resources and stakeholder involvement.

Stakeholder Engagement

When considering the development and implementation of opportunities, the stakeholders involved must recognize that FLW is a complex and systemic problem. Therefore, solutions should be systems-based and holistic, taking into account individual stakeholder needs and how interactions affect FLW. Stakeholders across the supply chain need to be deeply engaged in developing participatory approaches to increase ownership and buy-in to FLW initiatives so as to positively influence the effectiveness of solutions. For a list of stakeholder categories, please refer to Section 1.2.3; for key stakeholders, by country, see Appendix 2.

Systemic Changes

Identifying beneficial leverage points is important for changing the mindset, rules and structure of the prevailing food system, with the ultimate goal of shifting paradigms on FLW to create long-lasting change (Meadows 2008, 145, 194). For example, while market forces can reinforce efficiencies in some aspects of the value chain, they often do not sufficiently factor in external costs such as environmental effects and greenhouse gas (GHG) emissions. Therefore, policy and regulation interventions that incentivize environmental behaviors—such as reducing FLW—can instigate a more fundamental level of change and create a level playing field for businesses that are investing in solutions that keep environmental sustainability at the forefront (Interview U8).

Dynamic Execution

Lastly, the food system is dynamic, unpredictable and continually evolving. Even with thorough background research, stakeholder engagement, and planning, there are often unexpected conditions or unintended consequences that surface when pursuing opportunities. Using an experimental approach based on piloting and testing solutions before full-scale implementation can help in mitigating risks; enabling plans and approaches to actively be modified based on project results ensures that resources are used efficiently and effectively. For example, municipal and/or state/provincial-level efforts can often serve as living laboratories for experimentation and innovation that national governmental agencies can use as a resource to scale-up interventions nation-wide or for promoting dissemination of promising solutions.

7.2 Country-specific Considerations

In addition to the regional considerations for the opportunities noted above, the following subsections present country-specific considerations.

7.2.1 Canada

There are several factors to consider when implementing FLW-related opportunities within Canada. Canada's population is primarily concentrated along the southern border (Statistics Canada 2011). Other parts of the country generally consist of rural areas, with some scattered metropolitan regions across the northern parts of provinces and territories (Statistics Canada 2011). Due to this population distribution, food is often transported over great distances from rural areas (where most food is grown) to urban regions along the southern border. This is an important consideration when selecting interventions, since initiatives effective in more densely populated regions (e.g., Europe) may not work as well in sparsely populated regions of Canada.

In addition, Canada imports and exports a considerable amount of food, which adds complexity to the food supply chain. In 2015, Canada had US$33 billion of agri-food imports and US$41 billion of exports (Agriculture and Agri-Food Canada 2016). Furthermore, different aspects of the food supply chain involve municipal, provincial and federal governance, presenting challenges and opportunities for interjurisdictional and intergovernmental coordination. An emerging group of NGOs continues to advocate for FLW-related policy and program initiatives, creating momentum that can be further optimized as governmental bodies prioritize action on this issue.

7.2.2 Mexico

Most FLW in Mexico occurs in the upstream stages of the food supply chain, and although the scope of this report focuses on the stages of the food supply chain from post-harvest to retail, it was clear that pre-harvest activities are influenced by various activities in the ICI-production and consumption stages, and vice versa.

Therefore, existing and additional opportunities to integrate FLW initiatives into ICI-sector operations should be explored and implemented. Opportunities in the ICI sector also support one of the five goals of the National Crusade against Hunger—to minimize post-harvest FLW, which includes during the storage, transportation, distribution and commercialization stages of the food supply chain (DOF 2013).

Further, since agricultural production is the primary activity that contributes to biodiversity loss, due to the changes it makes to natural habitats (FAO 2013), and since the conservation and sustainable use of biodiversity is a leading policy focus in Mexico, the link between FLW and biodiversity loss should be considered when developing FLW strategies. The synergy between these environmental and social goals presents an opportunity to jointly move both the FLW agenda and the National Crusade against Hunger forward.

7.2.3 United States

As identified throughout the report, the US government announced a national FLW reduction goal and recently released a call to action (US EPA 2016b); other key initiatives are underway across multiple levels of government and within the private sector. Given that FLW is already an elevated topic—at least within companies and agencies working in the food sector—there are opportunities and challenges pertaining to the coordination of various initiatives already underway. These opportunities may help harmonize and build upon existing initiatives as key stakeholder groups continue to come together, and the public is increasingly aware of and engaged in addressing FLW. For example, in response to the proliferation of initiatives and support materials, the multi-stakeholder initiative Further With Food seeks to pull together and share high-quality information from various stakeholders about proven solutions and innovative new approaches to reducing food loss and waste. Information resources are submitted to Further With Food and then compiled onto the organization's searchable, user-friendly website (Further with Food 2017).

7.3 Cross-cutting Opportunities

Tables 44 to 47 present opportunities to address FLW. All opportunities listed apply to Canada, Mexico and the United States. Table 44 examines cross-cutting opportunities that apply across all stages of the food supply chain (agriculture, manufacturing, distribution, retail and foodservice). Tables 45 to 47 focus on specific opportunities to target source reduction, rescue and recovery, and measuring, tracking and reporting. Each opportunity has a brief description, implementation considerations, and stakeholders involved.

TABLE 44 outlines opportunities that cut across FLW source reduction; food rescue and recovery; and measuring, tracking and reporting. The opportunities apply across all stages of the food supply chain unless otherwise noted.

TABLE 44. Cross-cutting Opportunities

Opportunity	Description	Considerations	Stakeholders Involved
Develop FLW Policies	Establish and/or reinforce policies that address FLW, either as stand-alone initiatives or as components of other policies (e.g., national food policy, hunger relief, calls-to-action, zero waste) at national, provincial/state and municipal levels of government.	▪ Align FLW reduction targets for the retail and consumer levels with Target 12.3 of the United Nations' Sustainability Development Goals (SDGs): to reduce FLW from retail and consumer levels by 50% by 2030 and significantly reduce FLW from other parts of the food supply chain (UN 2015). ▪ Integrate feedback from departments at different levels of government and from the broader FLW stakeholder base. ▪ Include guidance on how to most effectively measure, track and report progress on goals, where relevant.	▪ ICI: Companies, associations ▪ Government: Environmental, agricultural, food, health agencies ▪ NGOs: Advocacy, food rescue
Foster Multi-Stakeholder Collaboration	Develop and/or expand upon multi-stakeholder partnerships or agreements for collaboration on implementing FLW initiatives and research in each country, as well as among the North American countries.	▪ Include key global partners (e.g., Champions 12.3) in North America–wide collaboration to address globalization of the ICI sector. ▪ Initialize implementation of FLW projects with an NGO or leading association, then expand to a broader set of stakeholders. ▪ Measuring, tracking and reporting on progress is important for evaluating the impact of initiatives and enabling improvements to use resources in the most effective way. ▪ Pool funding and in-kind resources to provide technical assistance to the ICI sector on FLW source reduction; food rescue and recovery; and measuring, tracking and reporting. ▪ Share data, case studies, lessons learned, updates on initiatives, research, and training resources, on an online platform.	▪ ICI: Companies, associations ▪ Government: Environmental, agricultural, food, health agencies ▪ NGOs: Advocacy, academia, foundations, food rescue
Create Voluntary ICI FLW Initiatives	Establish and/or reinforce voluntary agreements, FLW reduction targets or calls-to-action, to encourage ICI stakeholders to commit to taking action on FLW.	▪ Identify national organizations or agencies to spearhead and/or augment existing initiatives, along with establishing funding and timelines. ▪ Reinforce existing voluntary ICI FLW initiatives. ▪ Provide technical assistance (e.g., fact sheets, webinars), workshops and guidebooks, to help ICI stakeholders identify where FLW occurs and opportunities to avoid FLW. ▪ Leverage practices in multi-national companies and associations, to harmonize measuring, tracking and reporting on the progress of ICI-led FLW initiatives across the three countries.	▪ ICI: Companies, associations ▪ NGOs: Advocacy, foundations ▪ Government, including municipal, provincial/state and federal levels (legislative and executive): environmental, agricultural, food and health agencies
Strengthen Regional Collaboration	Form a North American advisory committee with a focus on FLW.	▪ Continue monitoring trilateral progress on FLW by engaging key federal government and other stakeholders on a regular basis. ▪ Pursue additional studies on FLW in the two other key parts of the food supply chain—farm production and consumers—or other priority needs identified in this report. ▪ Support community-led initiatives for FLW avoidance, through instruments such as the North American Partnership for Environmental Community Action (NAPECA) grants. ▪ Sponsor conferences to convene key stakeholders from the three North American countries on a regular basis.	▪ Government: Environmental, agricultural, food, health agencies

7.4 Source Reduction of Food Loss and Waste

TABLE 45 outlines opportunities for source reduction of FLW, along with considerations for implementation. The opportunities apply across all stages of the food supply chain unless otherwise noted.

TABLE 45. Opportunities for Source Reduction of Food Loss and Waste

Opportunity	Description	Considerations	Stakeholders Involved
Standardize Date Labels	Establish a guideline that standardizes date labels across the North American countries.	▪ Partner with industry, government and NGOs to develop and reinforce standard date labeling. ▪ Develop educational programs to raise awareness and competency on interpreting date labels and applying the standards, across the food chain. ▪ Review existing food labeling policies and mandates, to determine how best to balance food safety with FLW reduction.	▪ ICI: Associations; processing, distribution and retail companies ▪ Government: Agriculture and food agencies ▪ NGOs: Food rescue, advocacy
Reform Food Grading	Change cosmetic requirements for food grading to categorize more food as acceptable for primary markets, and harmonize grading guidelines across the North American countries.	▪ Evaluate the effect on import/exports and optimizing food usage. ▪ Provide education across the food supply chain—particularly at the retail level, where food grading is more stringent than legislation requires. ▪ Promote use of second-grade produce, through awareness and educational campaigns in the ICI sector, especially for retail and foodservice stakeholders. ▪ Create/promote secondary markets.	▪ ICI: Food producers, retail companies, and associations ▪ Government: Food and agricultural agencies ▪ NGOs: Food rescue and advocacy
Improve Cold Chain Management	Improve cold-chain management by using appropriate vehicles and storage facilities to minimize FLW.	▪ Pool funding and in-kind resources, to provide technical support to reinforce best practices in cold-chain management and for financing to upgrade equipment, especially for small and medium-sized enterprises with limited capital resources for upgrades. ▪ Develop clearer and more efficient protocols for border/customs staff, to prevent FLW from being created by delays in food inspections at border crossings.	▪ ICI: Companies and associations ▪ Government: Food, transport, border and agricultural agencies ▪ NGOs: Food rescue and advocacy
Expand Value-added Processing and Packaging Adjustments	Develop technologies to extend the freshness or shelf-life of food, through innovation in value-added processing and packaging.	▪ Cultivate innovation, by expediting regulatory approval processes for food products processed or packaged with new technologies, while also considering potential impacts or unintended consequences of a particular idea/innovation. ▪ Increase investment (private, government and foundation) in research projects that support development of technology, identifying and activating markets, and seeking uses for currently wasted products (and byproducts). ▪ Facilitate connections between stakeholders involved in value-added processing and packaging technology (e.g., surplus food generators, technology developers, investors).	▪ ICI: Processors, investors ▪ Government: Food and agriculture agencies ▪ NGOs: Academia, foundations, food rescue

7.5 Food Rescue and Recovery

TABLE 46 outlines opportunities for food rescue and recovery, along with considerations for implementation. The opportunities apply across all stages of the food supply chain unless otherwise noted.

TABLE 46. Opportunities for Food Rescue and Recovery

Opportunity	Description	Considerations	Stakeholders Involved
Explore Food Rescue Incentives	Explore various incentive mechanisms for food donations (if not already existing) and opportunities to expand funding to improve infrastructure related to storage, transportation, and donation-tracking in food rescue and recovery systems.	▪ Establish evidence to justify the need for, benefits of and selection of incentive mechanisms to support food rescue and recovery, in each country. ▪ Prioritize infrastructure to improve logistics and appropriate storage of healthy (often more perishable) foods. ▪ Address the dignity and right-to-food aspects of the food-insecure population: food quality, nutritional requirements, and accessibility of food, as pertain to vulnerable populations. ▪ Consider challenges smaller donors may face when attempting to take advantage of tax incentives, given lack of systems to track donations and limited infrastructure to store and transport donations.	▪ ICI: Companies, associations ▪ Government, including municipal, provincial and federal: environmental, agricultural, food and health agencies ▪ NGOs: Food rescue and advocacy

7.6 Measuring, Tracking and Reporting Food Loss and Waste

TABLE 47 outlines opportunities for measuring, tracking and reporting FLW, along with considerations for implementation. The opportunities apply across all stages of the food supply chain unless otherwise noted.

TABLE 47. Opportunities for Measuring, Tracking and Reporting Food Loss and Waste

Opportunity	Description	Considerations	Stakeholders Involved
Standardize Measuring, Tracking and Reporting	Use terms, definitions and reporting framework, in each country, that are consistent with the *Food Loss and Waste Accounting and Reporting Standard* (WRI 2016).	▪ Evaluate globally available approaches for measuring, tracking and reporting that may be applicable to North America. ▪ Promote use of the *Food Loss and Waste Accounting and Reporting Standard* (WRI 2016) across the three North American countries, to standardize measurement for monitoring and comparison purposes. ▪ Pool funding and in-kind resources, to develop robust measurement methodologies and provide technical support to stakeholders across the food supply chain so that they may employ comparable methods in measuring, tracking and reporting FLW.	▪ ICI: Companies, associations ▪ Government: Environment, food and agricultural agencies ▪ NGOs: Academia, foundations, food rescue and advocacy
Track and Report Performance	Establish benchmark (baseline) FLW for each country and track changes in FLW over time.	▪ Harmonize measurement methodologies across the three countries, to provide more accuracy and consistency. ▪ Build on existing reporting systems for FLW (e.g., census data and national surveys; taxation; corporate annual reporting; business permits and licensing; tracking of utility usage; tracking by industry associations; audits and tracking of GHG emissions inventory). ▪ Define a base-year for tracking FLW over time. ▪ Ensure consistency in tracking and reporting over time, to produce results that are reliable and comparable. ▪ Report FLW data on a regular basis, as agreed upon by all three countries, to evaluate progress on goals/targets (as applicable). ▪ Conduct full-life-cycle analysis of the supply chain for FLW, including greenhouse gas emissions, and environmental and socio-economic impacts.	▪ ICI: Companies, associations ▪ Government: Environment, food and agricultural agencies ▪ NGOs: Academia, foundations, food rescue and advocacy

8 Limitations of Analysis

The objective of this study was to provide an analysis of food loss and waste (FLW) in Canada, Mexico and the United States. The assessment delivered in the report:

- characterizes the scale and causes of FLW generation;
- identifies initiatives aimed at reducing, rescuing, recovering and measuring FLW;
- identifies successes and challenges faced by FLW projects, programs and policies (including both regulatory and non-regulatory tools) across North America;
- provides an analysis of the environmental and socio-economic impacts of FLW; and
- identifies opportunities for improving FLW reduction, food rescue, wasted food recovery and measurement.

Due to the emerging nature of FLW research, the project encountered several challenges. TABLE 48 shows the limitations of the analysis presented in this report, and potential options to overcome these limitations.

TABLE 48. Limitations of Analysis

Limitation of Analysis	Potential Options to Overcome Limitation
Current lack of primary data on FLW from some businesses, institutional sources, and international catering sources of waste (e.g., airlines, trains, cruise ships, military), which resulted in data gaps	Access additional unpublished data from the ICI and public sector. Include proxy data from other disposal methods (e.g., open dumping, sewage disposal, composting) of FLW, to generate a more comprehensive estimate.
Comparable methodology and scope for FLW measurement not available across North America	Use the framework in *Food Loss and Waste Accounting and Reporting Standard* (WRI 2016) to map out methodologies for comparison. Further define gaps/needs and development guidance, and support improved FLW measurement methodologies.
Country-specific data and quantification method for life-cycle greenhouse gas emissions analyses were not available for all three North American countries	Develop country-specific emission factors and methodology, based on available data and methodologies from other countries.
Country-specific data on environmental and socio-economic impacts were not available for all three North American countries	Build on existing environmental and socio-economic impact quantification models, using proxy data to customize by country.

9 Case Studies

9.1 Source Reduction of Food Loss and Waste

9.1.1 Approach 1 – Reducing Portion Sizes

Case Study 1. Canada: Adapting Food-Ordering to Customer Needs | Neighbourhood Group of Companies

Food Supply Chain Stage: Foodservice – Restaurant

The Neighbourhood Group of Companies operates four sit-down restaurants in the City of Guelph, Ontario, that promote sustainable and locally grown and crafted foods and beverages. With 150 full-time and part-time employees, the restaurant chain is an active member of the community. The owner has undertaken a number of initiatives to understand how and where food loss and waste (FLW) is generated, and how to reduce FLW.

Source: Neighbourhood Group of Companies 2016.

To understand how much waste was being generated, all kitchen and plated waste was measured over a three-month period. The results showed on average 0.6 kilograms of waste per guest, about 80 percent of which was FLW; the remaining 20 percent was recyclable materials or garbage. Of the FLW generated, 45 percent was kitchen FLW (e.g., vegetable cuttings, meat cuttings, eggshells) and the remaining was FLW from plated food.

The owner started to examine which dishes typically created FLW and how they were being prepared. The investigations revealed that the most common FLW in the kitchen was potato peelings from making mashed potatoes and the most common FLW on the plate was French fries. The owner responded to observations by eliminating potato peeling (i.e., by leaving the skins on the potatoes for mashed potatoes, potato salad and French fries), and by reducing French fry portions (see photo). In addition, the restaurants do not offer bread, since 40 percent is thrown out. Bread is provided to customers by request but it is not advertised.

After the success of the first FLW monitoring study, the owner initiated a follow-up project with the University of Guelph. The study showed that on average, 10 to 15 percent of plated food was coming back as waste; this was again dependent on the particular dish. For example, the item that generated the most FLW was the signature pulled pork served with side orders of mashed potatoes, bread, and coleslaw. This finding resulted in the owner's reducing the portion sizes of side orders, and now the dish produces negligible FLW. Condiments (e.g., ketchup) provided another example of observed FLW. Now staff ask customers if they want condiments and provide them in small bowls, which has reduced ketchup consumption by one third. Dessert portions were also identified as being too large and have now been halved in size, with the price reduced to reflect the change. This has resulted in a significant reduction in waste and a significant increase in the sales of desserts.

Positive Impacts: The owner has noticed overall savings in operating costs, both from reduced labor associated with food preparation (e.g., not having to peel potatoes) but also in food costs, making the restaurants more profitable now than before. Furthermore, the decision to support local foods and sustainable activities has resulted in greater growth in business and customer support.

Key Insights: There is a need to educate customers about FLW and to promote smaller portions and other waste-reduction initiatives in restaurants. Restaurants need to measure FLW in order to be able to identify opportunities to create less FLW and thereby increase overall savings for the business, by reducing portions.

Source: Interview C17.

Case Study 2. Canada: Trayless Dining and Smaller Plates | Dalhousie University

Food Supply Chain Stage: Foodservice – Institutional

In 2007, Dalhousie University conducted an audit to investigate generation rates of food loss and waste (FLW) and discovered that at the university's largest cafeteria an average of 227 kilogram of FLW was generated per day. Of the FLW generated, just over half of it came from plate waste and the rest from the kitchen. At the time of the waste audit, the cafeteria used trays.

Source: Dalhousie University n.d.

The waste audit results also showed that the greatest amount of post-consumer FLW was generated at dinner, and the least at lunch. On average, each student generated approximately 0.3 kilograms of FLW over the three meals.

When a survey was administered to the students who ate at the dining hall, 55 percent admitted to regularly leaving one quarter of the food on the tray as waste and 69 percent of respondents were aware of the fact that they were discarding uneaten food. Furthermore, 47 percent of students attributed poor food quality/taste to the main reason for the FLW and 33 percent admitted that their waste resulted from taking too much food. Almost all students surveyed (97 percent) were on a meal plan. When asked what could be done to reduce the amount of FLW generated, the most popular responses included increasing food quality and taste (38 percent responses), introducing controlled portion sizes and changing the type of meal plan provided.

Positive Impacts: In March 2008, almost one year after the waste audit, the university introduced trayless dining in all four of the residence dining halls. According to Aramark's Foodservice Director at Dalhousie, "Getting rid of trays is one of several environmentally friendly initiatives Aramark, the university's foodservice provider, is making these days. The move will also cut back on water and detergents used to clean and sterilize the 3,000 to 4,000 trays in circulation at Dalhousie each day." Aramark found that when it went trayless in universities and colleges, the amount of FLW was reduced by 25 to 30 percent. In addition to introducing trayless dining, the use of smaller dining plates has also now become standard practice. Aramark has replaced the larger 33-cm dinner plates with 23-cm plates, to further reduce plated FLW.

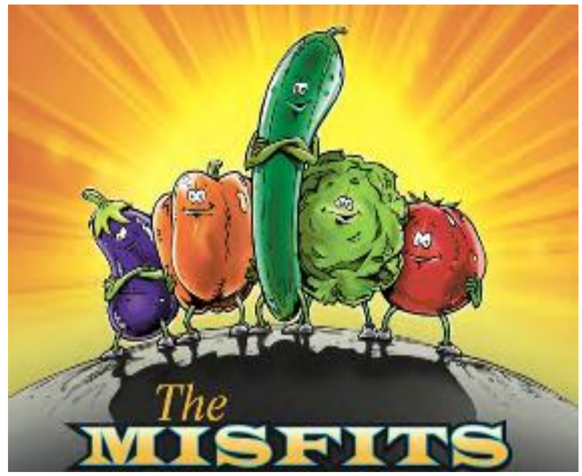
Key Insights: There are many opportunities to reduce FLW in the eating areas of campus dining halls and other large cafeterias, by implementing simple procedures such as trayless dining and use of smaller plates. Monitoring FLW in front and back of house is key to collecting the data to support change.

Sources: Wright 2007; Smulders 2008.

9.1.2 Approach 2 – Increasing Marketability of Produce

Case Study 3. Canada: The Misfits Campaign | RedHat Co-operative

Food Supply Chain Stage: Food Production Post-Harvest



Source: Meinhardt 2015.

RedHat Co-operative is a farmer co-operative in Southern Alberta that specializes in greenhouse-grown vegetables. It has more than 50 growers who produce approximately 36,000 tonnes of vegetables per year. Of these vegetables, 3–5 percent are second-grade. Since the vegetables are grown in greenhouses, they need to be picked and cannot be tilled back into the soil. Without markets for these vegetables, they are typically disposed of.

In 2014, RedHat Co-operative launched The Misfits, a produce line which is based on the Inglorious Fruits and Vegetables program created by Intermarché, a major grocery store chain in France. Instead of culling its second-grade produce, RedHat packed the produce and sold it at a discounted price to wholesalers and grocery stores. The program began as a pilot in Calgary, Alberta, with two grocery chains (Safeway and Co-op) and one wholesaler (Freestone Produce) participating. A pilot is currently running with Save-on-Foods, in Regina, Saskatchewan. Save-on-Foods is planning to expand this program to 35 stores in Alberta. RedHat is also selling The Misfits to wholesalers and distributors, which includes providing vegetables to Loblaw's Naturally Imperfect produce line.

Positive Impacts: In the initial pilots alone, approximately 23 tonnes of vegetables were sold as The Misfits. Customers were excited about the products and most stores sold out. Farmers benefit from The Misfits as they are able to increase their income from vegetables that they would have otherwise not been able to sell. Farmer morale has also increased, as there is often a feeling of guilt associated with disposing of edible vegetables. Due to demand for The Misfits, RedHat Co-operative has expanded and started brokering second-grade produce from the US and Mexico, to supplement supply from its growers, especially of vegetables that cannot be grown in colder climates or during the off-season. One distributor from the United States, Robinson Fresh, has purchased a license for The Misfits brand and is scaling the program up to 400 grocery stores.

Key Insights: There is demand and interest for The Misfits from farmers, wholesalers and consumers; however, retailers are still slow to scale up and expand the program beyond running pilots.

Source: Meinhardt 2015.

9.1.3 Approach 3 – Standardize Date Labels

Case Study 4. United States: Food Recovery Act and Food Date Labeling Act | United States Government

Food Supply Chain Stage: Processing, Distribution, Retail

Source: Pingree 2016.

To address the dual issues of food loss and waste (FLW) and food insecurity in the US, Congresswoman Chellie Pingree led an initiative to develop two pieces of legislation: H.R. 4184 – Food Recovery Act of 2015, and H.R. 5298 – Food Date Labeling Act of 2016.

According to a joint study by the Harvard Food Law and Policy Clinic, the National Consumers League and the John Hopkins Centre for a Livable Future, 84 percent of Americans discard perfectly edible food. The "Food Date Labeling Act" addresses the issue of date/expiration label confusions, which is one of the most common causes identified by consumers for why they throw away otherwise perfectly edible food. The Act, which was introduced to Congress on 18 May 2016, would standardize terms used for date labeling nationally, and would prohibit states from preventing food retailers from donating safe foods that are past their best-before dates to charities.

"The Food Recovery Act of 2015," introduced to Congress on 12 July 2015, complements the "Food Date Labeling Act of 2016" as it aims to promote and support food rescue at every stage of the food system (including farm, retail, school, military and even in Congress). The "Food Recovery Act" also seeks to promote more research on FLW prevention and reduction and on sustainable management of FLW, and proposes to develop a fund that will support infrastructural projects, to prevent wasted food from going to landfills. The "Food Recovery Act of 2015" was not enacted by the 114th Congress; it was subsequently reintroduced as two bills—S. 3108: Food Recovery Act of 2016, and H.R. 3444: Food Recovery Act of 2017. The "Food Date Labeling Act of 2016" was also not enacted by the 114th Congress and, as of the time of writing, has not been reintroduced.

Positive Impacts: Both of the proposed Acts will help support the national target to halve FLW in the country by 2030. While, at the time of writing, the two pieces of legislation have not been passed, they have generated discussion and brought attention to the issue of FLW in America. Celebrity chefs such as Tom Colicchio and diverse groups such as the Natural Resources Defense Council (NRDC), Rethink Food Waste through Economics and Data (ReFED), Harvard Food Law and Policy Clinic, and the Grocery Manufacturers Association (GMA) have all endorsed the bills.

Key Insights: The proposal of new legislation can bring more attention to the issue of FLW, even before it has been passed in Congress.

Source: Pingree 2016.

9.1.4 Approach 4 – Packaging Adjustments

Case Study 5. United States: Packaging Adjustments for Changing Lifestyles | Wegmans Food Markets, Inc.

Food Supply Chain Stage: Processing, Distribution, Retail

Wegmans Food Markets, Inc., is a private supermarket chain headquartered in New York, with 89 stores across the United States. Wegmans continues to be a leader in reduction initiatives for in food loss and waste (FLW), in the food retail industry.

Source: Wegmans Food Markets, Inc. 2016.

When Wegmans noticed a trend toward smaller household sizes, it recognized that customers were seeking to cook more efficiently at home. To meet its customers' needs and to reduce FLW, Wegmans adapted its food packaging to ready-to-eat or ready-to-cook individualized portions.

By sealing single-serving meat portions, Wegmans increased the shelf life of in-store meat and supported home FLW reduction, since customers are able to unseal one portion at a time for home preparation.

Previously, Wegmans sold bulk-packaged products at a discount, branded as "Club Pack" products. While the discount incentivized customers to purchase larger quantities, they would often waste the product at home. Wegmans shrank its "Club Pack" and rebranded it as a "Family Pack" in order to target the appropriate customers. In addition to reducing FLW, this initiative had the added benefit of educating consumers on portion sizes and on prioritizing quality over quantity.

Working with the chefs and food preparation staff in-store, Wegmans began to optimize blemished produce for ready-cut fruits and veggies, salads, and other prepared deli items. This practice resulted in the dual benefit of reducing "shrink" (or wastage) and offering time-saving healthy snacks to customers.

Positive Impacts: Some of Wegmans' initiatives have resulted in customers' purchasing smaller amounts of food. As a values-based company, Wegmans saw its first priority as serving its customers' needs at home, rather than encouraging higher quantities of sales and throughput. The company has been able to maintain its bottom line financially while using packaging adjustments to help reduce home FLW. What differentiates Wegmans from competitors is its holistic approach to diverting, preventing and reducing FLW. Wegmans also participates in the USDA's and EPA's Food Recovery Challenge. This commitment has translated into ideas to educate staff and into support for farmers by better purchasing and forecasting, as well as into collaboration with other retailers. The company has also reflected its focus on better measurement and tracking, by using the FLW Standard.

Key Insights: Adjusting packaging to reduce FLW in-store and at home may lead to less overall throughput but a financial bottom line can still be maintained. Wegmans' strong showing of value and commitment to customer service over sales numbers produces mutual benefits and demonstrates how a retailer can positively influence household FLW reduction. The challenge over time will be to seek ways to use easily compostable or recyclable packaging, in order to minimize overall waste generation.

Sources: Barnes 2015; Interview U39.

9.1.5 Approach 5 – Improving Cold-Chain Management

Case Study 6. Mexico: Database of Cold-Chain Transportation | The Mexican Transport Institute (Instituto Mexicano del Transporte—IMT)

Food Supply Chain Stage: Distribution

The Mexican Transport Institute (*Instituto Mexicano del Transporte*—IMT), a branch of the Ministry of Communications and Transportation (*Secretaría de Comunicaciones y Transportes*—SCT), was created in 1987 to address aerial, terrestrial, maritime and rail transportation issues. The institute conducts field-based research, technology development, transport regulation, specialized services, training, technology and knowledge dissemination, and technical assistance.

Source: Maines Paper and Food Service, Inc. n.d.

The IMT built a database to serve as a central repository of data collected by the SCT. The dataset includes information such as the origin and destination of loads transported in the country, transport companies and individual truck owners, types of loads, and cost of transportation per kilometer.

The IMT also developed a methodology to identify cold-chain management needs in the country by tracking movements of perishable load and identifying those that need refrigeration. Using the information compiled in this database, regions of the country with cold-chain management gaps were identified—such as the southeast region.

Although this database produced preliminary results on cold-chain management coverage and gaps, there are uncertainties due to aspects such as inconsistent classification of loads. Furthermore, the database may not be representative of all transport in Mexico. Despite these potential uncertainties and data gaps, this database can help target efforts for increasing the coverage of cold-chain management in Mexico.

Positive impacts: The database tracked a number of metrics on cold-chain management in Mexico. Cold-chain management increased five times from 2005 to 2015, nationally, from 11,951 to 54,904 units. Of these units, 37 percent are owned by companies and 63 percent by individuals. The average age of the trucks is 14 years, for the company fleets, and 22 years, for the individual-owned. Cold-chain management is concentrated in Mexico, with 56 percent of all cold-chain transportation units located in only six states (Nuevo León, Sinaloa, Estado de México, Guanajuato, Sonora and Jalisco). The states with the highest number of cold-chain units were Nuevo León and Sinaloa, each with 12 percent of all units. Coverage of cold-chain management is generally weak in the southeast region, with minimal changes in coverage from 2005 to 2015.

Key Insights: Although the results may not show a representative sample of the entire country and the database is still being developed, the results of the analysis provided some relevant conclusions that can be considered in designing strategies to increase the cold-chain management in Mexico.

Source: Morales 2016.

Case Study 7. Mexico: Pineapple Storage Study | Mexican Transport Institute

Food Supply Chain Stage: Distribution

Cold-chain management is a crucial process for fresh products like pineapples, as it is the only preventive measure to slow ripening. To test the impact of cold-chain management, the Mexican Transport Institute conducted a study to evaluate two modes of packing fresh pineapples for export and compared the damage from each packing method.

In the first method, pineapples were harvested directly and then transported to the city without cold storage or packing. This is a practice medium-sized companies commonly use for exports. Unpaved roads often needed to be used to transport products from the field to the packaging center, which contributed to fruit damage. The processes of harvesting, handling, packing and storing also added damage to the product.

In the second method, packing was done in a field near a cold storage facility before transportation. The pre-transportation facility was less than two kilometers from the field, which resulted in significantly less product damage. The product was cooled shortly after harvest, which also extended shelf life.

The study found that a temperature of 12°C is required to maintain pineapples for export to an international market, taking into account one month of storage time prior to sale.

Positive Impacts: Using cold storage immediately after harvest extends pineapple storage life significantly and reduces damage that leads to wasted product.

Key Findings: The export of fresh pineapples in a rigorously controlled process with cold storage directly after harvest can result in lower fruit damage and extended shelf life.

Source: Torre 2008.

9.1.6 Approach 6 – Value-Added Processing

Case Study 8. Canada: Broken Ladder Cider | British Columbia Tree Fruits

Stage of Food Supply Chain: Post-Harvest, Processing

BC Tree Fruits is one of the largest fruit-growing farm cooperatives in Canada, with more than 500 member growers and 13 packing facilities. Their growers are based in the Okanagan region of British Columbia. The primary crops grown by their members include apples, cherries, peaches, and pears. The average annual gross production is approximately 77 million kilograms of fruit.

Of the fruit produced, approximately 80 percent is sold as fresh fruit. The remaining 20 percent is culled. Although there are markets for culled fruit, of which the majority is destined for juicing and animal feed, the prices for fruit that go to these end-uses are very low. To find a better use for culled fruits, BC Tree Fruits pursued the cider industry. BC Tree Fruits partnered with Lonetree Cider Company to produce a cider from culled fruit, called Broken Ladder. There are three recipes under this product line: Authentic Dry, Ginger Apple and Cranberry Apple Cider. This cider is marketed as a minimally processed, 100 percent BC fruit product, which appeals to a growing consumer demand for more locally made craft beverages.

Source: BC Tree Fruits Cider Co. 2016.

Positive Impacts: In its initial rounds of production, BC Tree Fruits has repurposed 5 percent of its culls for cider and is planning to increase this to 25 percent (approximately 5 percent of gross production) as production ramps up. Since the cider is produced under BC Tree Fruits, the profits go not just to the processor but also to the cooperative's member growers, which gives them a higher-value market for their fruit.

Sources: Interview C7; McLeod 2015.

Case Study 9. United States: Just Peachy Salsa | Campbell Soup Company

Food Supply Chain Stage: Post-Harvest, Processing

Approximately 38,500 kilograms of peaches were disposed of annually by Eastern ProPak Farmers' Cooperative, mainly for aesthetic reasons. The peaches were either undersized or blemished and unsaleable at grocery stores. The cooperative was spending US$80,000 in annual dumping fees to rid itself of perfectly safe, edible fruits. Meanwhile, the Food Bank of South Jersey was faced with a growing food-insecure population, which required the charitable organization to distribute an additional two million pounds of food. To make matters worse, the Food Bank of South Jersey was threatened by funding cuts.

Source: CSC Brands L.P. 2013.

After discovering that perfectly edible peaches were being disposed of close by, the Food Bank of South Jersey purchased the peaches at a highly discounted price. However, the surplus of fresh ripe peaches was too much for the Food Bank of South Jersey to handle before they spoiled. The Food Bank of South Jersey contacted Campbell Soup Company (their regular donor) and came up with the idea of processing the peaches into peach salsa (which is a shelf-stable product).

In 2012, Campbell Soup Company, Eastern ProPak Farmers' Cooperative, Summit City Farms and the Food Bank of South Jersey partnered to create "Just Peachy Salsa" from otherwise wasted peaches. This case is a great example of a public-private partnership model. However, it should be noted that this solution might be challenging to scale up to other facilities that have processes that are more rigid and cannot be changed for a short period (peach harvest). Facilities with the ability to manufacture custom seasonal products would be able to take advantage of this type of opportunity.

Positive Impacts: With this innovative idea, the Food Bank of South Jersey was able to maintain its hunger relief programs while repurposing food that would have gone to waste. Campbell's donated the cost of manufacturing and packaging the salsa. In 2012, the Food Bank was able to make US$100,000 in profit and in 2013, 52,000 jars of "Just Peachy" salsa were produced. This program benefited many stakeholders across the food supply chain, from farms to processors to consumers.

Key Insights: While the Food Bank of South Jersey found a way to connect with the Farmers' Cooperative to save the peaches from being thrown out and had a supportive donor who was willing to assist in processing the peaches, there are more fruits and vegetables that are not being saved and other farmers /food banks that do not have the same resources or networks. Raising awareness and corporate buy-in to reduce wasted food will allow other food-processing companies to utilize produce that is rejected by the retail sector to benefit the charitable sector.

Sources: Donnelly 2015; CSC Brands, L.P. 2013; Interview U37.

9.2 Food Rescue and Recovery

9.2.1 Approach 1 – Increasing Rescue of Healthy Food

Case Study 10. Mexico: Banco de Alimentos de México Rescues Nutritional Food | Banco de Alimentos de México (BAMX)

Stage of Food Supply Chain: Secondary Market

Started in 1995, *Banco de Alimentos de Mexico* (Food Bank of Mexico—BAMX) is a private, nonprofit association. With its first food bank located in the State of Jalisco, BAMX currently comprises a network of more than 60 food banks, in half the Mexican states, and operates a distribution center in the city of Tepeji del Río, in the state of Hidalgo. BAMX is also a founding member of The Global Foodbanking Network.

BAMX rescues food that is no longer marketable and is at risk of being wasted but is still suitable for human consumption. Food is distributed to food-insecure communities to reduce hunger and improve nutrition. BAMX rescues food from various parts of the supply chain, including distribution centers, food markets, food manufacturing facilities, supermarkets, hotels and restaurants.

Source: Interview M44.

By 2014, BAMX had rescued 117,094 tonnes of food and distributed it on a weekly or bi-weekly basis. In 2013, the total value of food transferred was P$2.28 million. Almost 60 percent of the food distributed is fruits and vegetables, with the balance made up of grains, cereals and various proteins. BAMX distributes food to over one million people, representing close to 1 percent of the Mexican population.

More than 10,000 people work in the BAMX network; 46 percent are volunteers, 40 percent receive some in-kind payment, and the rest are staff and social service personnel. BAMX operates nationally and therefore acts as a single point of contact for donors, which more efficiently funds and supports multiple food banks across Mexico. BAMX coordinates its network of food banks and has standardized methods for food distribution across regions, in order to increase efficiency and optimize the use of food donations. BAMX also provides operational training to its member food banks and coordinates the work force across the network. BAMX regularly conducts surveys of its clients, to ensure that they are being reached effectively.

In 2014, BAMX began construction of the National Center for Collection and Distribution (*Centro Nacional de Acopio y Distribución*—Cenadi), in partnership with the Ministry of Social Development (*Secretaría de Desarrollo Social*—Sedesol) and the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*—Sagarpa). In 2015, the 3.8-hectare facility distributed 2,564 tonnes of food nationwide, covering 90 percent of the food bank network in Mexico.

Over 4,000 companies in Mexico donate to BAMX, and get receipts that can be used for a tax deduction for 5 percent of the donation’s value. In addition to strengthening donation networks, BAMX also creates agreements with non-food businesses. These partners participate as part of their Corporate Responsibility programs and contribute volunteers, donated funds, leadership, and business services to strengthen the capacity of food banks. An added benefit to these partners is positive publicity from BAMX, through online and social media channels. Organizations, including CMR, the Bank of America and Merrill Lynch, participate in more in-depth partnerships to focus on specific projects, such as restaurant food rescue. Carl Junior's and partners have engaged to fight hunger by creating a donation program through their foodservice outlets. There is also a Social Food Rescue Program (*Programa Social de Rescate Alimentario*) that has rescued nearly 45,000 tonnes of fresh fruit and vegetables since 2011, from food from rural farmers.

Positive Impacts: In 2014, through the National Crusade for Hunger, via Sedesol and Sagarpa, BAMX obtained P$237.5 million (US$12.5 million) to strengthen the infrastructure of food banks and food rescue in the countryside. The resources were used in the construction of 10 food banks, a National Distribution Center (Cenadi) and the rescue of more than 18,000 tonnes of fruit and vegetables in the Mexican countryside.

Key Insights: While there are still labor and logistics issues that make increasing distribution challenging, a nationally funded and operated network of food banks has proven to be an effective way to rescue food from various parts of the food supply chain and deliver it to Mexico's food-insecure populations across the country.

Source: Interview M44.

Case Study 11. Mexico: A Centrally Located Food Bank in Mexico City | Food for All (Alimento para Todos)

Stage of Food Supply Chain: Secondary Market

Established in 1994 with the support of Caritas Arquidiócesis de México IAP, Food for All (*Alimento para Todos*) is the largest independent food bank in Mexico. Located near the Central Supply Market of Mexico City (*Central de Abasto de la Ciudad de Mexico*—Ceda), Food for All rescues food from food loss and waste (FLW), along with electronics, clothes, shoes and other unused household items that have re-use value.

Ceda and supermarkets, food industries, bakeries and some restaurants are the primary food bank donors. Because Ceda's primary focus is fruits and vegetables, Food for All uses donations from the other organizations to compile nutritionally-balanced packages for distribution. For example, beans and rice are generally not donated and are purchased separately to balance the donation packages. Donors get a receipt for 5 percent of the donation value, in line with laws for tax deductions.

Source: Bergua 2016.

Over 82 staff and volunteers operate the food bank and are supported by a nutritionist, to ensure donation packages are balanced and best practices for food safety are followed. Since communities receiving rescued food send at least two volunteers each morning, maintaining production flow standards requires constant vigilance. Management systems are in place to keep up-to-date records on food inputs and where and how food gets distributed across socio-economic lines, as determined by partnering social workers. Food for All charges the recipient of rescued food 10 percent of the commercial value of the donations in order to maintain the perceived value of the food while also keeping the cost of the food minimal. Even without specific food handling regulations, regular audits are conducted by the *Junta de Asistencia Privada* (the board) and the food bank is visited regularly by the Commission for the Prevention of Sanitary Risks.

Positive Impacts: Food for All rescues and distributes approximately two tonnes of food weekly, to 32,000 people in vulnerable communities across Mexico City, Estado de México, Puebla, Morelos and Tlaxcala. Volunteers are critical to the success of the program and come from different companies, boy/girl scout groups, and schools. On average, 40 volunteers assist with the program daily.

Since 2014, Food for All and *Universidad Iberoamericana* (Ibero-American University) in Mexico City have organized an annual event called "Colloquium to reduce food insecurity," where experts discuss topics on food rescue. In partnership with producers in Milpa Alta, efforts are underway to rescue 1–1.5 tonnes of edible cactus (nopal) in excellent condition.

Lastly, Food for All worked with government institutions to strengthen the base of donation and more efficiently collect donations, through its exemption under the Not Driving Today Program (*Programa Hoy No Circula*).

Key insights: More awareness among the Ceda stand-owners would increase donors and beneficiaries for the food banks. Organizations such as Food for All work independently and do not have resources to access government support programs and tax incentives, to help offset operations expenses.

Sources: Interview M43; Alimento Para Todos IAP n.d.; Hoy No Circula 2016.

Case Study 12. United States: Nourish L.A. | L.A. Kitchen

Stage of Food Supply Chain: Secondary Market

Source: L.A. Kitchen 2015.

The L.A. Kitchen began as a pilot project in 2013, modelled after the D.C. Central Kitchen, a nonprofit and social enterprise that uses rescued food for job training and distribution of healthy meals and snacks to areas with low food security. In 2015, the L.A. Kitchen opened a full-scale, 20,000-square-foot facility, acting as the primary tenant in the LA Prep food processing hub. The facility was funded through a combination of foundation grants and nonprofit loans, and includes space for training, storage, food preparation, cooking, processing, and packaging. Currently there are 12 staff working at L.A. Kitchen, along with 40 partner organizations for culinary training, food distribution, and volunteer programs.

Multiple programs run under the umbrella of L.A. Kitchen:

- Reclaim L.A.: Rescuing unsaleable produce from farmers and wholesalers
- Empower L.A.: Culinary training for foster youth and former prison inmates
- Nourish L.A.: Distribution of healthy food to social service agencies
- Engage L.A.: Intergenerational volunteer program for people to prepare food together
- Strong Food: Social enterprise fulfilling contracts for seniors' meals and value-added food products

Through Nourish L.A., healthy meals, snacks and food products created from rescued food are distributed to social service agencies in Los Angeles, including after-school programs, drug treatment centers, senior centers, and empowerment programs for homeless populations. Rescued food is delivered or picked up, and then transported to the L.A. Kitchen's facility for cold storage. At the facility, the staff works with nutritionists to develop predominantly plant-based non-perishable food products or meals that meet state and local regulations. Food is prepared by an integrated team of staff, culinary students, and volunteers in the health-code-approved processing space. Meals, snacks, and food products are packed in the cold packing room, for distribution.

Positive Impacts: By providing "from scratch, healthy, mostly local, good tasting food," Nourish L.A. is filling the increasing demand for free, low-price and reduced-price meals to vulnerable populations who want higher-quality and nutritious food. Nourish L.A. has a goal to provide 990,000 meals, snacks, and wholesale products to social service agencies each year. Nourish L.A. is also helping social service agencies save millions of dollars. This savings can be used for the agencies to further their programs instead of paying for foodservices.

Key Insights: There is a demand and need for integrated social services that offer healthy and dignified food to customers, not just food to fill bellies. Food rescue organizations can aspire to improve the quality of food and health of vulnerable populations, build job skills of people who have barriers to employment, and create a diverse community through volunteer programs that break down socio-economic silos.

Sources: L.A. Kitchen 2016; Interview U33.

Case Study 13. United States: Affordable Grocery Store | The Daily Table

Stage of Food Supply Chain: Secondary Market


Source: The Daily Table 2015.

Founded by a veteran of the grocery industry, The Daily Table is a nonprofit grocery store that opened in June 2015 in Dorchester, Massachusetts, with a goal of using rescued and donated food from a variety of sources to offer low-cost food in underserved neighborhoods. One of the primary tenets of Daily Table's stated mission is to compete with other common, prepared-food and fast-food options by offering "ready-to-cook" and "grab-n-go" prepared meals at competitive prices. That includes selling healthy meal options at price points to match fast-food alternatives and at the same time offering an upbeat and dignified retail setting. As part of that effort, Daily Table does extensive food preparation on-site, with cooks and sous-chefs, most of whom are local hires.

Still in a pilot phase and not yet self-sustaining, Daily Table founder Doug Rauch hopes to build sufficient scale and reduce costs of goods to meet their mission and cover costs. The enterprise is very clear in its intent to address two problems simultaneously: wasted food and food insecurity. Daily Table is located in a low- and middle-income neighborhood that suffers from the "food desert" effect of having difficulty attracting reasonably priced, healthy and nutritious food. Rauch says "Daily Table is really a health initiative masquerading as a retail store."

On the food-sourcing side of the operation, Daily Table receives donated or very-low-cost food from a variety of sources. The food includes items typically offered by food banks; supermarket extras; and produce from local farms collected by volunteer gleaning groups. Daily Table also purchases food at market rates, when it is needed to expand offerings or to fill recipe ingredients. About half of the food is donated and the other half is purchased, usually at very low cost.

Positive Impacts: The social benefits are in offering healthy food at reduced prices to underserved communities. In terms of wasted food, Daily Table is piloting a model for offering a new secondary market for food items that would potentially become wasted food. Still in its early stages of development but looking to expand, Daily Table uses food rescue to address food insecurity by offering healthy, prepared meals in a retail setting.

Key Insights: Daily Table is testing the viability of using food donated and purchased through secondary markets. These food items are transformed during careful preparation and cooking into appealing, healthy, prepared foods and grocery staples that are sold in a retail setting to underserved communities.

Sources: Luna 2015; Kazda 2016; Mott 2015.

9.2.2 Approach 2 – Storage and Transportation Improvements

Case Study 14. Canada: Grocery Meat and Food Terminal Rescue Programs | Moisson Montréal

Stage of Food Supply Chain: Secondary Market

Moisson Montréal is a food bank that specializes in rescuing perishable food products, such as meats, vegetables and fruits. Most of the food rescued (85%) needs to be kept cold or frozen; this contrasts with the situation at most food banks, which rely on rescuing mostly dry goods. Since most food banks cannot afford the investment in trucks that have freezer capabilities and in large cold/freezer storage units, Moisson Montréal has assumed the role of a central collection, storage, and distribution hub for perishable food products. Due to its large size, Moisson Montréal uses a software-based inventory tracking system, which allows the organization to track incoming and outgoing donations. Moisson Montréal redistributes the perishable food to food banks located throughout the Province of Quebec; however, it requires the food banks to come to the distribution center to collect the food. When organizations pick up the food, they go through a grocery check-out type of system linked to the software, so that Moisson Montréal can track exactly how much food is distributed.

Source: Moisson Montréal 2015b.

In 2015, Moisson Montréal worked with 293 agri-food suppliers (including food manufacturers, distributors and grocery stores) to collect perishable foods, which are distributed to over 250 community-based organizations on a regular basis. The food helps feed over 146,000 people each month.

Meat and fish are the food items most in demand from community organizations. To help accommodate this need, in 2013 Moisson Montréal implemented a pilot project with ten grocery stores (Loblaws), to rescue meat that was near the best-before date and would have been thrown out. The success of the pilot resulted in the project's being expanded to stores located throughout the Montreal area. Today about 110 grocery stores participate in the meat rescue project.

Meat that is no longer wanted by the supermarket is placed into plastic containers and put in the freezer until it can be collected by the organization. Moisson Montréal has three freezer trucks dedicated to the grocery store and meat program and manages between 200 to 220 pick-ups per week from the participating stores, or about 40 pallets per day. At the same time, Moisson Montréal will pick up other food products (e.g., bakery, fruits, and vegetables) from the stores but most of the emphasis is on meat.

Moisson Montréal emphasizes control quality at every stop, with every plastic bin identified by number and tracked manually. Upon reaching the distribution center, the meat is repackaged and categorized and the information is entered into a computerized program for warehouse management. This approach developed in response to brand-risk concerns identified by some donors.

The meat is stored in a freezer at Moisson Montréal until it is ready to be collected by the agencies, at which time the frozen meat is placed in polystyrene coolers to keep it frozen while being transported. All meat is tracked and the information is sent back to each store on a monthly basis.

The meat is re-distributed only to agencies involved in food transformation (e.g., community kitchens, meals providers, such as The Salvation Army, Meals-on-Wheels, etc.) that have staff that are trained for safe handling and cooking of meat. It is not donated for food baskets, due to health and safety concerns. There are approximately 90 agencies in the program and the meat donations cover 100% of the meat needs of these agencies.

During the pilot, Moisson Montréal did not receive as much meat as anticipated and found out that many of the grocery store staff did not understand the nature of the project and who would be benefitting from the donations. In response, Moisson Montréal developed a training program for employees of grocery stores, to explain the program, who benefits and how to participate. A seven-minute animated video was developed, along with an interactive training program for the employees. The training resulted in a doubling of the meat donations.

In addition to grocery stores, Moisson Montréal started working with vendors at the Montreal Food Terminal located at Marché Central, to collect fruits and vegetables that were not sold at the end of the day. The Montreal Food Terminal generates an estimated 50 tonnes of wasted food per day. Moisson Montréal has a dedicated truck that collects 20–25 pallets of perishables every day, which is equivalent to 8–10 tonnes of food. Of the food rescued, about 85% is considered edible, with the remaining 15% being inedible. Drivers must evaluate the quality of the produce to ensure that the vendors are not trying to offload inedible food. If this happens, then Moisson Montréal will send a representative to talk with the donor and try to work out a solution. If the problem persists, then Moisson Montréal will remove the vendor from its donor list for a period of time. The Food Terminal supplies 70% of the fruits and vegetables collected by the organization.

Positive Impacts: About 60,000 to 65,000 kilograms of meat per month are rescued by participating grocery stores. The remaining food is donations from the Montreal Food Terminal (35%) and other suppliers (55%). With the success of the meat rescue project, Moisson Montréal has been working to expand the project to other grocery stores in the Montreal area. The organization is also working to help other organizations outside Quebec, e.g., Second Harvest, establish similar programs in their area. Moisson Montréal has a major project in the works for determining a way to rescue 100% of the unsold fruits and vegetables at the Montreal Food Terminal, thus ensuring the rescue of 50 tonnes of fresh produce now wasted every day.

Key Insights: The Quebec government has announced that within the next five years it will introduce a provincial law banning organic material from disposal throughout the province. Staff at Moisson Montréal see huge obstacles that will need to be addressed prior to the implementation of the law, including the need to de-package all food before it can be sent for processing into animal feed or for composting. The process to set up de-packaging will be very expensive, as the infrastructure to accommodate it will need to be developed. By-laws may need to be re-examined, to ensure that the pre-packaged food can be transported, stored and re-purposed.

Sources: Interview C32; Moisson Montréal 2015a; Moisson Montréal 2015b.

9.2.3 Approach 4 – Liability Protection for Donors

Case Study 15. Canada: Guidelines for Industry Food Donation | BC Centre for Disease Control

Stage of Food Supply Chain: Post-Harvest, Processing, Retail, Foodservice

The British Columbia Centre for Disease Controls (BCCDC) is an agency of the Provincial Health Services Authority and is responsible for investigating and evaluating the occurrence of communicable diseases in British Columbia. The organization provides provincial and national leadership in public health, through surveillance, detection, prevention and consultation and provides both diagnostic and treatment services directly to people with diseases of public health significance. Acknowledging that many British Columbians depend on food bank assistance and on other charitable organizations for food, BCCDC developed two guidelines on food security and food donations.

The first document, *Guidelines for Food Distribution Organizations (FDOs) with Grocery or Meal Programs*, was developed to provide guidance on liability issues, and relationships with volunteers and other FDOs, as well as guidelines on nutritious and safe foods that are suitable for donations. The document also provided samples of Memorandum of Understanding (MOU) agreements, as well as flowcharts to evaluate frozen, cold and boxed foods.

Source: BCCDC 2015.

The second document, *Industry Food Donation Guidelines*, was developed specifically for business owners, managers and decision makers, to establish the rationale for donating food, guide them on how to start and manage a food donation program, explain which types of foods are suitable for donations, address concerns about liability issues, and assist the industry in connecting with FDOs.

Positive Impacts: Since the first publication of them in 2015, the guidelines have been updated to provide additional information on a range of diverse services offered by BCCDC's initiative. Another component of the updated guidelines is a focus on how FDOs can communicate effectively with industry, volunteers and other FDOs.

The guidelines have proven to be useful as a platform for partnership and collaborations. For example, charitable organizations such as the Greater Vancouver Food Bank and Food Banks BC, together with the Metro Vancouver Regional District, have worked in collaboration to develop both guidelines. The guidelines also demonstrate the importance of developing relationships between FDOs and donors as well as the significance of rescuing and redistributing safe and healthy foods.

Key Insights: It is clear that the need to update the guidelines was due to a growing interest in supporting healthy and safe food donations. Restaurants Canada, the national non-profit association representing the restaurant and foodservice industry, has also promoted the guidelines on its industry website, to facilitate food donations. The key for success is awareness on the part of potential donors that donation of healthy food is relatively easy to navigate and that there is growing support and resources from organizations such as BCCDC.

Source: BCCDC 2015.

9.2.4 Approach 5 – Online Food Rescue Platforms

Case Study 16. United States: Smart Phone App | Food Cowboy

Stage of Food Supply Chain: Secondary Market

Food Cowboy is one of several recently developed smart phone apps attempting to fill a gap in the food rescue system in the United States. Founded to better connect the millions of entities that generate excess and unwanted food at grocers and restaurants with people who need it, the app connects the donors directly to the receiving charity.

Donors with excess food and charities that want the food to support their anti-hunger initiatives register using the app. When donors post available food, the charities receive an alert with the location, contact information, type and size of the donation. They are permitted to accept only what they want and can use. The app also includes a mutual rating system similar to those of other peer-to-peer apps that incorporate public ratings and comments.

Source: Food Cowboy n.d.

The Internal Revenue Code allows food companies to deduct 50% of the fair market value minus the cost of food when they donate excess food instead of sending it to landfill. Food Cowboy charges a 15% commission on that "lost profit" for each donation made through the app. It uses the charge to fund its operation and build the service. Food Cowboy also plans to donate two thirds of revenue up to $50 million a year to helping charities cover the costs of extending operating hours, obtaining donations, and increasing cold storage.

In July 2016, Food Cowboy began using some of the profit to support two initiatives that will fund startups, and technologies for reducing FLW. Food Cowboy established The No Waste Promise Alliance and the Food Waste Innovation Fund so as to invest up to $75 million per year in public- and private-sector solutions for dealing with wasted food.

Positive Impacts: As of June 2016, Food Cowboy had over 400 charity users and 200 donors. Building on mobile technology, owners of Food Cowboy and other apps consider their companies as technology startups in a testing phase. As startups, they rely heavily on building scale to meet their goals and have a meaningful impact on the problem of wasted food.

Key Insights: The ubiquity and ease of use of mobile technology, coupled with the large potential tax benefits, have made direct connection of donors and recipients easier. If widely adopted, apps like Food Cowboy could dramatically expand the donation of excess food and provide a streamlined mechanism for both donors and charities looking for food donations.

Sources: Interview U32; Food Cowboy 2015; Strom 2016.

9.2.5 Approach 6 – Feeding Animals

Case Study 17. Canada: Fish Feed from Insect Larvae Raised on Wasted Food | Enterra

Stage of Food Supply Chain: Secondary Market

Source: Enterra Feed Corporation 2016.

Conventional fish feed is produced by harvesting small wild marine fish and mixing them with soy into pellet-shaped products. The production of soy for fish feed uses up scarce land and water resources. Born out of these concerns, Enterra has a mission "to secure the future of the world's food supply by solving two global problems: wasted food and nutrient shortage." Its business is to make dried larvae feed for fish meal and poultry meal, as well as organic fertilizers to be used on local farms. Enterra upcycles nutrients from pre-consumer wasted food collected from generators such as farms, supermarkets, greenhouses and bakeries, and feeds it to larvae of the black soldier fly. The larvae are then harvested and turned into feed products. The larvae themselves are also edible by humans, making them a potentially effective source of protein, should consumers be more open to consuming insects, but in Canada they are not currently approved for human consumption. The company is currently producing more than 110 million soldier fly larvae per day.

Positive Impacts: The upcycling and recovery of pre-consumer wasted food is a key component of this business and allows it to solve numerous problems, including overfishing, land degradation and water scarcity. Enterra plays an important role in food recovery by closing the food system loop and tying waste management back to food production. Another positive side effect of feeding wasted food to larvae is that this process also produces a manure-type product, which can be used as a natural fertilizer. In terms of organic processing methods, Enterra's is high value in comparison to windrow composting or anaerobic digestion and is climate-change friendly, producing no methane and minimal carbon dioxide.

Key Insights: Enterra has been able to close the loop on wasted food through a process of upcycling the nutrients from wasted food back into the food chain. It provides a sustainable protein source for fish and poultry and a great source of fertilizer for agriculture. The company is expanding internationally and sales are growing, especially in the United States. Enterra has become the first manufacturer of an insect protein product to have completed the registration process for it as a feed ingredient in Canada. This product is currently approved for use in poultry feeds, and the company submission for use in fish feed is pending.

Sources: Enterra Feed Corporation 2016; Tamminga 2015; Cook 2014.

Case Study 18. Mexico: Producing Fish Meal from Fish Waste | La Nueva Viga Fish Market

Stage of Food Supply Chain: Secondary Market

La Nueva Viga is the largest fish and seafood market in Mexico and Latin America, and the second-largest such market worldwide. *La Nueva Viga* distributes 1,500 tonnes of fish and seafood per day (fresh and frozen), which constitutes 70 to 80 percent of Mexico's total production. The market center distributes products primarily to small markets, restaurants, other cities around the country and to direct retail.

Source: Bergua 2016.

La Nueva Viga has 422 producers and distributors: 202 wholesale stores, 55 retail stores and 165 medium-sized wholesale stores, called *tianguis* (of which 132 are restaurants), occupying a space of approximately nine hectares beside the Central Supply Market (*Central de Abastos*) in Mexico City.

La Nueva Viga receives fish and seafood mainly from domestic production, but also receives products from imports. Most of the fish comes from the Mexican coast, about 12 hours away from Mexico City. Approximately 30 to 40 percent of the fish is sent frozen from its place of origin, and the remaining fish comes fresh to the marketing center via cold transport.

The products are sold fresh within two days, on average. *La Nueva Viga* has two strategies for managing the surplus fish that is not sold. A small amount of the fresh product received is frozen, then sold onsite. The remaining unsold fish still in good condition is combined with fish scraps and saved for processing, Marketed as fish waste, it is sold to fish meal-producing companies.

Positive Impacts: Before 2013, *La Nueva Viga* paid waste haulers to pick up fish waste for disposal. The quantity of waste represented approximately 2 percent (11,000 tonnes) of the total product volume entering the market annually, and the cost of collection was approximately P$160,000 per month. Since 2013, instead of paying for collection, *La Nueva Viga* receives around P$215,000 per month to sell fish waste for processing. Due to the success of this project, *La Nueva Viga* has plans to enlarge and formalize the wasted food recovery system, assess other food recovery internal mechanisms and investigate other byproduct distribution. Instead of being sent to landfill, fish waste is recovered as a food product, with corresponding positive environmental impacts.

Key Insights: A good practice for managing fish oversupply is to freeze and then sell products. When freezing is not viable, a secondary option is to use the fish for processing into a more stable product, such as fish meal, which also results in creating a secondary market for this product stream.

Sources: Compesca 2013; Interview M56.

Case Study 19. Mexico: An Example of Food Recovery for Animal Feeding | Medellín Market

Stage of Food Supply Chain: Secondary Market

Market Melchor Ocampo, commonly known as *Mercado Medellín* (Medellín Market), is located in the heart of Mexico City. With over 504 stalls, this market offers a wide variety of perishable food products. These include fruits and vegetables, meat, poultry, fish and grains. Approximately 20 percent of the products in this market are imported from Colombia, Peru, Argentina, Cuba, Venezuela and other Latin American countries. The diverse range of immigrants represented at the market may explain why immigrant support–related nonprofits are actively involved in food recovery at this site.

Source: Bergua 2016.

Fruits, vegetables and fish carcasses are thrown into the disposal area, which is cleared every two days by the “pepenadores,” or waste pickers who reroute viable food for recovery. An estimated five to 10 kilograms of food waste is generated from each vendor. This is representative of 5 to 10 percent of what the owners buy for their individual stall. Surplus food is donated to existing nonprofit organizations that help immigrants who are in need of food. Some vendors donate excess groceries and cold meats to market visitors.

Chicken byproducts from Medellín Market and a nearby Colonia Juárez market are sent to a pig farm in Texcoco, Mexico City, for animal feed. Fish carcasses are also used as animal feed. Fish leftovers are used as inputs at other food processing industries.

Positive Impacts: An estimated 30 tonnes of chicken and fish byproducts are diverted to animal feed, and there is potential to divert more.

Key insights: Other Mexican markets are likely generating considerable food waste amounts that are currently disposed of in landfills instead of being recovered for alternate uses. These practices could be better managed by introducing food recovery initiatives and regulations—in coordination with key stakeholders, such as animal feed processing companies. The coordination between different stakeholders can help ensure safe handling and management of cold-chain, equipment and space usage for diverting surplus food to animal feed.

Sources: Interviews M71 and M72.

9.3 Measuring, Tracking and Reporting Food Loss and Waste

9.3.1 Approach 1 – Waste Composition Analyses

Case Study 20. Canada: Food Waste Characterization Study | Metro Vancouver Regional District

Stage of Food Supply Chain: Processing, Retail, Foodservice

The Metro Vancouver Regional District regularly commissions waste characterization studies in order to acquire data on food loss and waste (FLW) quantities disposed of as garbage, from all sectors, and as organics for composting, from the single-family residential sector. Waste characterization studies are also used to track progress toward diversion goals: 70 percent of all waste by 2015 and 80 percent by 2020. The most recent studies were timely, as Metro Vancouver passed the Organics Disposal Ban in 2015. The ban requires residents and businesses to separate foods scraps and clean wood from their garbage.

Source: Metro Vancouver 2015.

The Metro Vancouver 2014 Waste Composition Study focused on the institutional, commercial and light-industrial (ICI) sector. Four major ICI industry groups were studied because they generated the most solid waste and presented opportunities for waste reduction: accommodation and foodservices, business commercial services, manufacturing, and retail trade. A total of 98 garbage samples were hand-sorted into 130 material subcategories. Most (90 percent) of samples were collected directly from the participating business, allowing more detailed and accurate sorting. The 2014 study introduced a new waste characterization subcategory—“donatable food waste”—separate from the previously used subcategory of “compostable food waste.” Donatable food refers to items such as packaged foods, produce, grains and canned goods from grocery stores that have passed their “sell by” date but not their expiration date; ready-made, edible food items from convenience stores and cafés; and a portion of FLW from restaurants that is a result of over-purchasing.

The Metro Vancouver 2015 Solid Waste Composition Report studied a broader range of sectors: ICI, single-family residential, multi-family residential and drop-off or self-haul customers. A total of 107 garbage samples were hand-sorted into 138 material subcategories. The 2015 study introduced specific subcategories for the identification of food waste as “avoidable” or “unavoidable.” In this study, avoidable food waste refers to foods that could have been eaten, such as leftovers or plate scrapings. Unavoidable food waste refers to food (or drink) waste that is not edible under normal situations, such as bones, egg shells and tea bags. Avoidable food waste includes subcategories for whole fruits and vegetables, whole meats and fish, full/unused ready-made packaged items, baked goods, deli items, and liquids (packaged drinks and oils).

Positive Impacts: When the ICI sector participated in its 2014 study, Metro Vancouver found that many property managers and businesses were interested in joining because they wanted better information on the performance of their existing organics programs, or wanted opportunities to implment new programs, especially in anticipation of compliance with the Organics Disposal Ban. The data were also useful for evaluating the effect of ICI FLW reduction and diversion programs on quantities and types of materials disposed of at Metro Vancouver’s solid-waste facilities and to track progress toward diversion goals. The detailed FLW categories help focus Metro Vancouver’s efforts on the sectors that create the most waste and on the potential reasons for that waste. Detailed categories, by type of food, such as meats versus vegetables, allow Metro Vancouver to estimate greenhouse gas (GHG) emissions from FLW more precisely.

Key Insights: The ICI waste composition analyses did not just serve as a measurement tool, but also as an outreach tool to help businesses improve waste diversion. For the residential sector, by studying materials separated for organics collections as well as garbage, Metro Vancouver obtained a more complete estimate of FLW. As more jurisdictions include FLW in curbside composting programs, conducting composition studies for organics becomes important, in order to avoid underestimating quantities of FLW.

Sources: Metro Vancouver 2015b; Metro Vancouver 2016.

Case Study 21. United States: Food Waste Data Used to Support State of Massachusetts Commercial Organics Waste Ban | Massachusetts Department of Environmental Protection (MassDEP)

Stage of Food Supply Chain: Processing, Retail, Foodservice

In October 2014, the Massachusetts Department of Environmental Protection (MassDEP) established the Commercial Organics Waste Ban, which requires all businesses and institutions disposing of over one US short ton (0.9 tonnes) of commercial organic material per week to divert that organic material from disposal as trash. MassDEP found that 25% of its discarded waste is composed of FLW and other organics. Massachusetts set a goal to divert at least 35% of FLW from disposal by 2020, increasing diversion by more than 385,000 tonnes per year. Targeted business and institutional sectors include hotels, supermarkets, convention centers, large institutions, FLW processors and institutional foodservice providers.

Source: Biocycle 2013.

To plan for and manage their Commercial Organics Waste Ban, the MassDEP and stakeholders needed better information on organics generation and disposal. MassDEP detailed measurement and data analysis activities in its Organics Study and Action Plan (most recently updated in 2016). These measurement efforts include:

- **Food loss and waste density mapping** – Identifies major sources of FLW and can assist haulers and processing facilities with routing and facility locations.
- **Waste characterization** – Analyzes organic portions of waste stream from Massachusetts waste composition study conducted every three years.
- **Food loss and waste generation data** – Quantifies current FLW diversion by State facilities with the Lead by Example Program and gathers information on how to increase diversion at institutions such as universities, correctional centers and hospitals; also surveys large food manufacturers, processors and other large generators on their organics generation.
- **Monitoring of statewide efforts** – Establishing a baseline and developing a program measurement protocol to monitor statewide efforts; example metrics include permitted composting capacity and tonnes diverted.

Positive Impacts: The information MassDEP collects helped generators, collectors and processors of organics make sound infrastructure investments. This information also helped inform where to target direct government assistance FLW prevention, rescue and recovery programs. MassDEP periodically updates its action plan and continues to collect data to monitor statewide efforts, which helps track progress on organics diversion and provides data on the effectiveness of Massachusetts's strategies to divert FLW.

Key Insights: To help businesses determine if they dispose of one US short ton of organic waste a week, the MassDEP-funded program RecyclingWorks Massachusetts provides free technical assistance, informational workshops and online tools and guides for businesses to estimate their FLW amount. The MassDEP Organics Subcommittee is part of the Solid Waste Advisory Committee, which contributed to developing the Massachusetts 2016 Organics Study and Action Plan.

Source: Massachusetts Department of Environmental Protection n.d.

9.3.2 Approach 2 – Diaries

Case Study 22. Mexico: People-centered Approach toward Food Waste Management in the Urban Environment of Mexico | PhD dissertation

Stage of Food Supply Chain: Consumer

As part of a PhD dissertation, a method was developed and implemented to measure food loss and waste (FLW) from residential dwellings in Mexico City and Jiutepec (Morelos). Data collection tools generated qualitative and quantitative information from households, to capture behaviors concerning FLW, types of wasted food and amount of food disposed of. The data collection process included a household-based survey and an FLW diary in which participants recorded and weighed food that they disposed of in their homes.

Participants were recruited from areas of varying affluence, to ensure a diverse representation of households in Mexico City and Jiutepec. In total, 120 households participated in this study.

Detailed demographic information was collected from the households so as to explore various socio-economic factors that may affect FLW. These factors included type of dwelling, access to water and sanitation, street cleaning frequency, education, average size of residence, type(s) of meals most frequently shared at home, location of home and average household size.

The household survey also included questions about FLW separation habits, such as separation of FLW from other household garbage, usage of a compost system and collection frequency of waste. It also inquired about community involvement, such as perception of community participation, and personal degree of attachment to the neighborhood.

The FLW diary was recorded by a member of each participating household for a seven-day period. For each meal consumed at home, each type of FLW was recorded and weighed. The location of disposal (e.g., compost, kitchen drain, general kitchen bin) and the type of FLW (e.g., vegetable/fruit peelings, raw food /meat scraps, beverage, spoiled food, cooked food /excess food) were also recorded. The most common types of FLW encountered were fruit and vegetable peelings.

The data collected estimated that FLW disposal was 0.2 kilograms per capita per day in less affluent areas and 0.14 kilograms per capita per day in more affluent areas.

Positive impacts: This study provided valuable information to local government agencies, NGOs, and other food system stakeholders working to understand and address FLW issues. The detailed socio-economic analysis highlighted correlations between FLW and social factors as well as behaviors that shape FLW in different neighborhoods.

Key insights: Combining socio-economic surveys in conjunction with FLW studies can provide actionable information connecting FLW behaviors and demographics information. The community-centered approach enables stakeholders to create tailored strategies that effectively target needs and behaviors of different socio-economic groups.

Source: Jean-Baptiste 2013.

Case Study 23. United States: Cutting Down Food Loss and Waste and Food Cost | Gold Strike Resort and Casino, MGM

Food Supply Chain Stage: Foodservice

Gold Strike Resort and Casino, in Robinsville, Mississippi, serves more than 650,000 guests each year. It contains a range of different dining options for guests, including a steakhouse, quick bites, lounges and buffet. The Gold Strike team was concerned about FLW from the all-you-can-eat buffet. Rising food prices spurred action, as it was clear that the current methodology of using prep sheets, par lists and production guides was not sufficient. In 2014 the team began tracking waste with the LeanPath 360 program, installing LeanPath Trackers in two kitchens so as to specifically track and help reduce FLW.

Source: Gold Strike Casino Resort n.d.

When the management team unveiled the program to its staff, it was met with a mixed reaction—some staff were excited, and some were suspicious that this was a program to track individual performance. To encourage staff to use the program, the management team implemented rewards for staff engagement, recognizing the person with the most transactions each week as the "top tracker" and rewarding him/her with a free meal at the buffet. At the pre-shift meeting, the team talked about who was in the lead, creating friendly competition among the group, which led to full participation and accurate data collection.

One of the biggest findings for the team after the tracking process was well underway was that breakfast items made up a significant portion of FLW. They discovered the teams were continuously producing full batches of product until the change-over time of 11:00 am. At the end of the breakfast period, they were throwing away pans of pork product, eggs, and pancakes, all due to overproduction. Once the staff started seeing the FLW numbers tied to the overproduction, they started cutting back production. Certain items were shifted to à la carte cooking, including pancakes, French toast, and other items that could not be saved and repurposed at the end of the shift. This transition provided a fresher product for the customers and significantly less waste at the end of the meal period.

Positive Impacts: After using the LeanPath 360 program for 12 months, the Gold Strike Buffet had reduced pre-consumer FLW by more than 80 percent and food costs had dropped by 5 to 6 percent on average each month. In addition, it has increased staff engagement and awareness concerning FLW.

Key Insights: It is not always apparent what is being wasted until it is measured. By setting up FLW measurement systems, kitchens can identify where and how much FLW is occurring and then use that information to create viable solutions.

Source: LeanPath n.d.a.

9.3.3 Approach 3 – Surveys

Case Study 24. United States: Food Waste Study | Food Waste Reduction Alliance

Stage of Food Supply Chain: Processing, Foodservice, Retail

In 2011 the Food Waste Reduction Alliance (FWRA) set out a three-year plan with non-profit think tank BSR, to assess the current US food industry landscape in order to better understand the scale of food loss and waste (FLW) and the challenges that contribute to FLW. The plan included gathering quantity data on edible food donations, food re-use and recycling and other FLW disposal, directly from participating companies in the manufacturing, retail and foodservice sectors. Research also addressed challenges to increasing donation, re-use and recycling.

Source: Food Waste Reduction Alliance 2013.

The three studies conducted by FWRA and BSR used progressively more-extensive data to develop statistics and national estimates of FLW from the sectors covered:

2012 BSR Food Waste Assessment—the initial study to estimate FLW, based on publicly available data.

2013 Analysis of US Food Waste among Food Manufacturers, Retailers and Wholesalers—the second study, based on primary data collected from food companies through surveys with responses from:

- 13 manufacturers, representing approximately 17 percent of the projected sales from the US manufacturing sector; and
- 13 retailers/wholesalers, representing approximately 30 percent of projected sales from the US grocery retail/wholesale industry.

2014 Analysis of US Food Waste among Food Manufacturers, Retailers and Restaurants—the third and final study, also based on primary data collected from food companies through surveys with responses from:

- 16 manufacturers, representing approximately 17 percent of projected sales in the US manufacturing sector;
- 13 retailers/wholesalers, representing approximately 32 percent of projected sales in the US grocery retail/wholesale sector; and
- 27 restaurants (14 companies with no more than 10 locations each), representing approximately 32 percent of projected sales in the US restaurant industry.

Positive Impacts: This first-ever US food industry assessment allowed FWRA members to analyze the current state of the industry's FLW management practices and to provide benchmark data to measure progress in reducing FLW. FWRA's study demonstrates cross-industry collaboration as an option for gathering FLW data.

Key Insights: The data collected in FWRA's reports allow companies to compare their performance against that of their peers, both in adoption of best practices and in generation of FLW. FWRA's reports and information about decreasing FLW challenges can inform the food industry and policymakers about where further collaboration and solutions are needed.

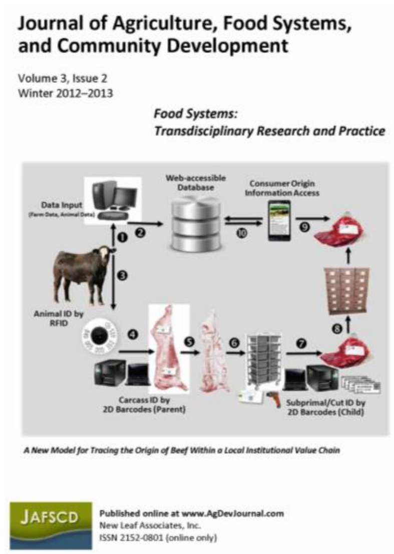
Sources: BSR 2012; BSR 2014; BSR 2013.

9.3.4 Approach 4 – Models and Proxy Data Extrapolation

Case Study 25. Canada: The Importance of Quantifying Food Waste in Canada | Journal of Agriculture, Food Systems and Community Development

Stage of Food Supply Chain: Retail

The authors of the 2013 academic paper *The Importance of Quantifying Food Waste in Canada* highlighted the importance of quantifying the amount of food loss and waste (FLW) along the food supply chain in Canada. They estimated the amount of FLW in Canada from 1961 to 2001 for different food category types, at the consumer and retail levels. To provide the estimations, they proposed a quantification methodology for FLW that applies secondary data from Statistics Canada on food availability, food loss, and spending on food, to supplement the lack of detailed FLW data in Canada.



Source: Journal of Agriculture, Food Systems and Community Development 2013.

Statistics Canada compiles data from “a wide variety of sources, both survey and administrative, and from various divisions within Statistics Canada along with other government departments” on food availability for the following major categories: fruits, vegetables, animal products (including red meat, poultry, eggs, milk and cheese), cereals, sugar and syrup, oils, fats and beverages. Statistics Canada estimates food loss using adjustment factors developed by the US Department of Agriculture Economic Research Service.

The authors also used data from Statistics Canada on personal income and consumption spending to examine spending on food in total, and spending on food purchased from stores versus from restaurants, separately. Analysis identified that increases in spending on food from restaurants has outpaced increases in spending on food from stores; however, the authors concluded that more research is needed to assess whether or how this shift in spending has affected increases in FLW.

This study found that:

- FLW is estimated to have increased by 40 percent from 1961 to 2009;
- the increase in FLW was larger than the increase in available food for consumption over that time; and
- the highest percentage of FLW was found in vegetables and fruits while the lowest percentage was in pulses and nuts.

A conclusion of the authors was that increases in the consumption of fresh vegetables and fruits—both perishable products—may be contributing to the increase in FLW.

Positive Impacts: This quantification study helps provide much-needed data (such as that FLW in Canada increased over time between 1961 and 2009) about Canada’s FLW amounts on a national level. It also suggested that available food for consumption per person, per-capita GDP, and per-capita income may be factors that increase FLW. By using historic data, this methodology allows researchers to assess trends in FLW from the past to the present, unlike methodologies that require new data collection. The authors hypothesize that FLW quantification data will increase awareness about FLW and food purchasing and eating habits. This awareness may then promote FLW reduction and improve food security; food quality; and sustainability in the economy, community and environment.

Key Insights: Applying Statistics Canada data was helpful in its methodology, but has limitations—such as having to use food loss data from the US instead of Canada. The authors recommend conducting a replicable pilot study to collect primary data for quantifying FLW along the food supply chain in Canada. This methodology can be used to compare FLW over time to other factors such as Canada's population or different food categories, so as to help assess trends and determine where to focus FLW intervention efforts.

Source: Abdulla et al. 2013.

Case Study 26. Canada: "$27 Billion" Revisited: The Cost of Canada's Annual Food Waste | Value Chain Management International

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

In 2014, the consulting firm, Value Chain Management International (VCMI), revisited its FLW estimations from its 2010 *Food Waste in Canada* report. Its updated estimate that C$31 billion worth of food is wasted annual in Canada is a 15% increase from its C$27 billion estimation in 2010. This 15% increase was due to newly available FLW data and insights about seafood (including catch and processing) and parts of international catering waste that were not included in the previous study.

Source: Gooch et al. 2014.

VCMI's estimations were produced by analyzing existing data, particularly from Statistics Canada, information gathered from communications with the commercial food industry, and other assumptions. VCMI applied the methodology summarized in TABLE 49, to estimate the economic value of FLW along the value chain (on-farm, processing, transport and distribution, restaurant and hotels, retail, consumers, international catering waste) in Canada.

TABLE 49. Value Methods Used in Value Chain Segments

Value Chain Segment	Value Method
Farm; Processing; Transport and distribution	Applied industry stakeholder estimates of average percentage waste at the field, during processing and packaging and during transportation and distribution, to the dollar value of agricultural and seafood products sold in Canada in 2012.
Restaurants and hotels	Applied industry stakeholder estimates of the percentage of FLW in a "well-run restaurant" plus an additional assumption regarding the percentage plate waste, to the dollar value of food purchased from restaurants in Canada in 2011.
Retail	Applied industry statistics provided confidentially; no further details on the estimation method were provided.
Consumers	Applied Statistics Canada's 2007 estimates of solid and liquid FLW, in kilograms per person, to the current population. Applied assumptions on prices per kilogram (separately for solid and liquid foods) to estimate the dollar value of wasted food.
International catering	Developed assumptions regarding the average number of in-flight meals per passenger per flight, the percentage of FLW, and the dollar value of each meal. Applied assumptions to the number of international passengers traveling to or from Canada in 2012.

Positive Impacts: By presenting the dollar costs of FLW, rather than tonnages, this study builds the financial case for businesses to evaluate and redesign their operations to prevent avoidable food loss and associated waste. This report is also the only report in Canada currently that breaks down the sources of FLW by stage of the food supply chain.

Key Insights: While the quantifiable value of FLW was estimated in this report, the true value is more likely to be higher, due to the omission of other food-chain sectors which were not included in the study because of limited available data. FLW imposes substantial costs on businesses and consumers in Canada, but these costs are often hidden or not apparent. This quantification methodology can be expanded by obtaining data for additional institutional sectors.

Source: Gooch et al. 2014.

Case Study 27. Mexico: Food Losses and Food Waste | World Bank

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

The World Bank conducted a study that examined the quantity of FLW in Mexico and its associated environmental impacts.

The methodology selected to calculate the national FLW was informed by international studies, including FAO's. The study used data extracted from the National Survey of Income and Expenditure in Households (ENIGH), the restaurant industry, the defense industry (military), Agriculture Atlas, and the Agri-Food and Fishery Information Service (*Servicio de Información Agroalimentaria y Pesquera*—SIAP).

Production tonnage estimates for 79 food products were reviewed and extrapolated, in order to estimate the national FLW tonnage. The food items were selected from the ENIGH to represent a typical Mexican diet. For each of these products, the wasted food was calculated by adding together domestic production and imports, then subtracting exports and consumption. The remainder is considered waste. Note that this type of calculation does not include inedible parts of food, which are still a part of FLW. Furthermore, it does not differentiate between wasted food that is disposed of, versus composted or fed to animals. The total FLW was estimated to be 20.4 million tonnes per year, using this method.

The ecological footprint and water footprint associated with a select portion of the 79 product groups were calculated: The ecological footprint of 29 product groups was equivalent to 37 million tonnes of carbon dioxide, and the wasted water of 24 product groups was equivalent to 40 trillion liters.

Positive Impacts: This study identified some of the causes, quantities and environmental impacts of FLW, on a country-specific level, which had not been done before for Mexico. This information will be used to develop intervention strategies for an integrated approach to manage FLW and maximize food rescue and recovery.

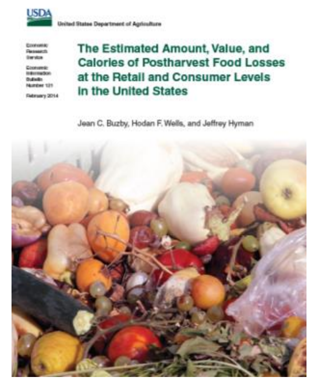
Key Insights: Developing a product-based approach to estimate the quantity of FLW and its associated environmental impacts gives an additional level of detail that is specific to the food type. This is helpful in determining what types of food are wasted more, and solutions that target products versus FLW in general.

Source: Aguilar Gutiérrez 2016.

Case Study 28. United States: Loss-Adjusted Food Availability Data Series | USDA

Stage of Food Supply Chain: Retail

The United States Department of Agriculture (USDA) Economic Research Service (ERS) maintains the Loss-Adjusted Food Availability (LAFA) Data Series for over 200 agriculture product types. Food loss includes all post-harvest losses, such as food spoilage, non-edible food parts, plate waste, and cooking and moisture loss. The LAFA data are used primarily to adjust estimates of food availability and to monitor food intake and diet quality by estimating the per-capita number of calories and food patterns in the five major food groups and the amounts of added sugars, sweeteners, fats and oils. However, the loss assumptions in the LAFA Data Series have also been used by ERS to estimate the amount and value of food loss at the US retail and consumer levels. The amount of food loss is estimated by multiplying the quantity of that food product available for consumption by the appropriate loss assumption.



Source: Buzby et al. 2014.

In 1992, ERS initially developed the food loss coefficients by using published reports and input from product experts; many reports dated from the mid-1970s or earlier and did not cover retail- and consumer-level losses. In 2005, ERS began a systematic study to update the coefficients with more-recent data. ERS worked with agricultural and academic institutions to update primary (e.g., farm) conversion factors. Working with consultants, ERS updated retail losses by comparing shipping and point-of-sales data in national supermarket chains. Losses at the consumer levels were estimated by comparing food purchase data from Nielsen Homescan (a market research dataset) with food consumption data from the National Health and Nutrition Examination Survey.

Positive Impacts: The LAFA Data Series is an important resource for the USDA ERS in estimating the amount of food loss and food available for consumption over time. These estimates from the USDA can help US governments and food industries get a better perspective on the food loss amounts and food group types and better inform their planning for FLW prevention and reduction initiatives. Researchers in other countries, such as Canada, use USDA coefficients—as used to develop USDA models—as the best available estimate of food loss.

Key Findings: The USDA's 2014 report, *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States*, estimated for the first time the amount of calories associated with US food loss from the retail and consumer levels: 141 trillion calories per year, or 1,249 calories per capita per day, in the food supply in 2010. The top three food groups, in terms of share of total value of food loss, were meat, poultry and fish (30%); vegetables (19%); and dairy products (17%).

Source: Buzby et al. 2014.

9.4 Policy and Education/Awareness Programs

Case Study 29. Canada: Food Waste Reduction and Practices Toolkit | Provision Coalition

Stage of Food Supply Chain: Processing, Distribution, Retail

Provision Coalition, a Canadian food and beverage manufacturers association, developed a free online sustainability portal as a one-stop sustainability resource for food and beverage manufacturers. The portal provides information, case studies and tools to help manufacturers assess, monitor and improve their social, environmental and economic performance and goals.

The Provision Coalition Food Waste Working Group launched a Food Waste Reduction and Practices Toolkit to help food companies quantify their avoidable food waste, calculate the value of their waste (disposal costs) and implement best practices to reduce avoidable food/beverage waste at the source, thus reducing the resulting greenhouse gas (GHG) emissions from its disposal. The toolkit has the potential to be adapted for other sectors across the value chain. Food companies can access the toolkit through Provision Coalition's online portal, to track and update their progress as often as needed. The toolkit consists of five sequential guidance stages:

- Quantifying food loss and waste (FLW)
- Identifying root causes of FLW
- Selection and evaluation of possible solutions
- Implementation of solutions
- Monitoring of solutions

PROVISION COALITION

PROCESSING FOOD SUSTAINABLY

Source: Provision Coalition 2017.

Positive Impacts: The Food Waste Reduction and Practices Toolkit is designed to help manufactures better measure and manage their FLW. Provision Coalition also hopes to gather the aggregated data once manufacturers begin to use the toolkit. By going beyond measurement to helping food and beverage manufacturers identify causes of FLW, select solutions and monitor results, this measurement tool could provide valuable information on the effectiveness of various FLW reduction strategies.

Key Insights: Provision Coalition is leveraging its relationships and collaboration within the food industry and other stakeholders to bring education on, awareness of and tools for reducing and prevent FLW.

*Source***:** Provision Coalition 2017.

Case Study 30. Mexico: Pilot Programs for Operational Changes | Simapro

Source: Flores 2016.

Stage of Food Supply Chain: Processing, Foodservice

The International Labour Organization (ILO) developed the Integral System of Measurement and Productivity Improvement (*Sistema Integral de Medición y Avance de la Productividad*—Simapro), a methodology used to promote jobs and sustainability. This was achieved through dialogue among managers, worker's representatives, middle managers and operations staff about improving productivity, work conditions and equity within the organizations. Development also focused on workplace training to build the capacity of staff to identify opportunities to improve processes and ensure ongoing communication between operational staff and management. Food loss and waste (FLW) was one of the topics reviewed in the methodology and identified as one of the most profitable opportunities (through savings from reduced inputs) for optimizing efficiency.

Positive impacts: In a pilot conducted in Bahia de Banderas (Riviera Nayarit) the methodology was implemented in five restaurants and one hotel. The methodology resulted in an average 32-percent reduction of FLW (532 kilograms in total among the pilot participants). The pilot participants saved a total of US$36,000 as a result of the FLW reduced. Key intervention points were identified in food procurement, storage, and preparation of dishes to better suit customer needs. Changes that were implemented as a result of the pilot included:

- better organization of fridges to control food supplies;
- standardization of menu options, recipes and portion sizes;
- improved presentation of plates to customers;
- offering customers choices for their side dishes;
- overall cost control through tracking supplies; and
- increased awareness among staff about optimizing resources.

In the state of Chihuahua, the program was implemented in small and medium-sized enterprises in the dairy industry, as well as in several restaurants. Some improvements that reduced FLW in a dairy company were:

- improved sanitation in milk production, to ensure the product is uncontaminated;
- regulation of thermostats in incubation rooms that previously had variable temperatures;
- modification of the production process of Manchego cheese to reduce losses from 12 kilograms per batch to four kilograms per batch; and
- modification of production process of Chihuahua Cheese, resulting in a 2.5 percent efficiency increase.

Key Insights: Technical assistance to identify and implement improvements in the food processing and foodservice sector helps reduce FLW and improves productivity.

Source: Interview M12.

Case Study 31. United States: EPA Excess Food Opportunities Map| US EPA

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

The US EPA plans to publicly release its new Excess Food Opportunities Map, along with a report estimating excess food generation rates from industrial, commercial and institutional sources. The US EPA grouped industry classes into the following sectors: food manufacturers and processors, food wholesalers and distributors, educational institutions, the hospitality industry, correctional facilities, the healthcare industry, and the foodservices sector.

The map and report will identify generators of FLW and FLW recipients across the country. It will include a database of approximately 500,000 potential excess food "generators" in the US, with the business or institution's name, geographical location, and an estimate of its excess food generation, as well as a database of approximately 4,000 potential recipients for excess food and scraps. The recipients include food banks, anaerobic digesters, and composting facilities. The report will also describe data sources and methodologies the US EPA used to estimate the excess food generation rate from US industrial, commercial and institutional sources.

Positive Impacts: The US EPA hopes local governments and project developers use the tool to gauge potential sources of FLW in specific geographic areas so that they can more effectively focus their efforts in FLW prevention, edible food donation and FLW recovery. It is another tool for stakeholders to use to communicate FLW information with one another and map out opportunities for collaboration. The tool may also influence how infrastructure is developed, depending on feedstock availability.

Key Insights: EPA's FLW model was based on and inspired by the success of its interactive Waste to Biogas Mapping Tool, which promoted partnership among stakeholders in methane-rich biogas production. The states of Massachusetts, Connecticut, South Carolina and Vermont have used similar methodologies to derive estimations of FLW generation rate.

Sources: Interviews U22 and U6.

Case Study 32. United States: National Food Loss and Waste Reduction Goal | USDA and EPA

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

Source: USDA 2015.

The US EPA and the USDA, led by Agriculture Secretary Tom Vilsack and the US EPA's Deputy Administrator, Stan Meiburg, announced on 16 September 2015 the first national goal to reduce FLW by half by the year 2030. This first-ever goal to reduce domestic FLW is aligned with target 12.3 of the United Nations Sustainable Development Goals. In pursuit of this goal, both the US EPA and USDA are seeking to partner with communities, businesses, charitable organizations and faith communities, as well as partners at every level of government (state, tribal, local).

There are three key objectives to this reduction goal: the first is to reduce waste to help feed the hungry, the second is to create an economic incentive for families and businesses to save money, and the third is to protect the environment.

An important component of the FLW reduction goal is measurement and tracking. Using available data from 2010, which pegged the FLW at 99 kilograms per person from residential, commercial and institutional sectors, the goal aims to halve the amount of FLW to 49.6 kilograms per person. As for food loss, in 2010, food loss totaled 60.3 billion kilograms. Therefore, the FLW reduction goal aims to reduce this waste by 30 billion kilograms.

Positive Impacts: Two years prior to the announcement of the United States Food Loss and Food Waste Reduction Goal, the USDA announced the United States Food Waste Challenge, which created a platform for numerous stakeholders across the food supply chain to use to collaborate and share best practices. In 2014, the challenge had recruited over 4,000 participants and surpassed its original goal of reaching 1,000 participants by the year 2020. The US EPA Food Recovery Challenge predates the Food Waste Challenge, and also serves as a successful incentive-based tool, with 950 participants. In addition, the national commitment to halve FLW by 2030 has also encouraged better measurement and tracking, as well as more resources for research and innovation.

Key Insights: The historic announcement of the food loss and waste goal has established a set of objectives that will contribute to addressing the issue of climate change, hunger and environmental sustainability. Considering that the United States produces a significant amount of FLW, this policy shift is important, and it is critical to continue to address FLW across the food supply chain.

Sources: Geiling 2015; US EPA 2016f; USDA 2015.

Case Study 33. International: The Courtauld Commitment | Waste and Resources Action Programme (WRAP), United Kingdom (UK)

Food Supply Chain Stage: Retail, Foodservice

In 2000, the UK government created the Waste and Resources Action Programme (WRAP), a government-funded NGO that advises businesses on how to reduce waste and use resources efficiently.

In 2007, the UK government published a National Waste Strategy for England. The report introduced several goals, one of which was to focus higher up the waste hierarchy to reduce household waste. To achieve these targets, WRAP was given the mandate and authority to develop and oversee programs and policies that would target different industry sectors and households.

Source: Moore 2016.

The Government launched the Courtauld Commitment in 2005, a voluntary program encouraging retailers to commit to reducing packaging and FLW. UK businesses (retailers, manufacturers and brand owners) were invited to commit to reducing their waste. While it was launched before WRAP's Love Food Hate Waste (LFHW) program, which targets FLW reduction in the household, the Courtauld Commitment has become closely tied to the LFHW program, recognizing that retail plays an important role in how and why household FLW occurs. The Courtauld Commitment has been rolled out in four phases:

Phase 1 (2005–2010) and Phase 2 (2010–2012): These phases focused on identifying solutions to reduce FLW and primary packaging waste in grocery stores and food retailers. Phase 1 focused on engaging over 40 retailers that signed the agreement to reduce FLW, design out packing waste growth, and reduce the total amount of packing waste. It succeeded in achieving the first two goals, reducing FLW by 270,000 tonnes in 2009/2010 compared to the previous year and reaching zero-growth in packaging waste in 2008. Efforts to reduce the overall amount of packaging were stymied by a 6.4-percent rise in grocery sales. Phase 2 aimed to build on Phase 1 by focusing on household FLW, the carbon impact of grocery packaging, and supply chain product and packaging waste. Through the provision of timely updates, online tools, research and other resources available on its website, WRAP supported signatories in achieving their reduction targets. Phase 2 resulted in a 3.7-percent reduction in household FLW (compared to a target of 4 percent), but avoidable FLW was reduced by 5.3 percent, saving consumers over 700 million pounds (£) and local governments over £20 million each year. Furthermore, it achieved its targeted goal of 10-percent reduction in the carbon impact of grocery packaging, and exceeded its target for reduction in supply chain packaging, achieving 7.4-percent reduction instead of its goal of 5 percent.

Phase 3 (2013–2015): A goal was set to reduce the weight and carbon impact of household FLW and grocery product and packaging waste, both in the home and in the UK grocery sector. The targets were to: reduce traditional grocery ingredient, product and packaging waste in the grocery supply chain by 3 percent, and household food and drink waste by 5 percent, by 2015 (based on a 2012 baseline), resulting in an overall reduction of 9 percent from the 2010 baseline. There were 45 UK signatories—which included retailers, manufacturers and brand owners—to this phase.

Phase 4 (2016–2025): This multi-goal phase targets: 1) resource use in the manufacturing of food, 2) FLW reduction, and 3) GHG emissions reduction through FLW reduction initiatives. The one target aims to reduce resources used in producing food and drink by 20 percent over the period and to reduce FLW by 20 percent in all UK post-harvest sectors, including production, manufacture, distribution, retail, hospitality and foodservice, and households. As of March 2016, over 100 UK-based food retailers, brands, foodservice companies, trade bodies and local authorities had signed up. The food-retail signatories represent over 93 percent of the 2016 UK food retail market.

To help industry maximize FLW reduction actions, WRAP established a Manufacturing and Retail Working Group in 2015. The group is supported by a range of guidance documents, tools and case studies focusing on FLW prevention, as a first priority, redistribution of food surplus, as a second priority, and diverting suitable surplus to animal feed, as a third priority. The information gathered and insights gained will help WRAP develop further strategies to achieve the FLW reduction targets and will inform delivery of Courtauld 2025.

Positive Impacts: According to WRAP, the Courtauld Commitment has been widely embraced by governments and industry: "The Courtauld Commitment receives ministerial backing from all four Governments of England, Northern Ireland, Scotland and Wales. The agreement supports the policy goal of a 'zero waste economy' and the objectives of the Climate Change Act to reduce greenhouse gas (GHG) emissions by 34 percent by 2020 and 80 percent by 2050 […] and major retailers, brands and suppliers have pledged their support."

WRAP's involvement with the food industry has been critical to the success of the campaign, as the food industry has helped convey to consumers important environmental messages (i.e., where consumers expect to receive information in order make better purchase decisions about what they buy), and introduce changes at the retail level that make it easier for consumers to take action. Some examples of initiatives introduced by supermarket chains include:

- Sainsbury's "Love Your Leftovers" campaign;
- Warburton's removal of "display until" dates from all of its products, leaving a more prominent "best before" date;
- Kingsmill's reduced product sizes, such as reflected in its "Little Big Loaf;" and
- Tesco's "Buy One Get One Free Later" (BOGOFL) promotional program.

In Phase 2, the Courtauld Commitment achieved a 1.7–million-tonne reduction in food and packaging waste, having a monetary value of £1.8 billion, or US$2.2 billion, and a GHG emissions saving of 4.8 million tonnes of CO_2e—and it continues to make impressive strides. As of 2015, signatories had achieved 3.2-percent reduction in grocery ingredient, product and packaging waste, resulting in positive reduction in CO_2e of 3.9 percent.

Key Insights: Following the initial success of the Courtauld Commitment, WRAP has started working with the hospitality and foodservice industry to address FLW. In June 2012, WRAP launched its Hospitality and Foodservice Agreement (HaFSA), under which the foodservice industry voluntarily commits to reducing its food and packaging waste by 5% and increasing recycling to 70%. WRAP has established a number of resources targeting FLW in the hospitality and foodservice sector, including the following:

- A webpage, entitled "Supporting resources for the Hospitality and Foodservice sector," which is full of resources to help reduce FLW.
- A resource pack for the hospitality and foodservice sector, to help industry members in education and engagement of consumers in reducing plate waste.
- Tracking and measurement work sheets, to help in measuring and monitoring FLW.
- Case studies on foodservice companies that have successfully reduced FLW.

Sources: Moore 2016; WRAP 2010; WRAP 2013; WRAP 2015; WRAP 2016a.

Case Study 34. International: Quantification of Food Surplus, Waste and Related Materials in the Supply Chain | WRAP UK

Food Supply Chain Stage: Retail, Foodservice

The United Kingdom's initiative to reduce FLW is managed by the Waste and Resources Action Programme (WRAP), a registered charity that works with UK governments and other funders to help implement policies and programs on waste prevention and resource efficiency. UK food and drink business sectors participate in Courtauld 2025, a voluntary industry agreement whereby UK stakeholders along the food value chain participate in meeting FLW reduction and prevention targets. They also help the UK meet its commitment to the UN Sustainable Development Goal 12.3.

Source: WRAP 2016.

In 2015, WRAP established a Manufacturing and Retail Working Group to research and develop strategies to address FLW prevention. With oversight from the Working Group, WRAP conducted a comprehensive study in 2016, *Quantification of Food Surplus, Waste and Related Materials in the Supply Chain*, to improve the understanding of FLW data at manufacturing and retail businesses and track the UK's progress toward its FLW reduction goals.

The key research objectives were to:

- estimate the amount of food surplus and waste at grocery retail stores and food manufacturers;
- estimate the amount that might be prevented, donated for human consumption, or diverted to animal feed; and
- identify the most significant causes of food surplus and waste.

The FLW quantification methodologies and definitions used in WRAP's research are consistent with the guidance from the EU FUSIONS project (described in Case Study 35). Data and insights were gathered from multiple published reports and statistics; site visits and waste audits at individual businesses; interviews; and surveys. In particular, the retail FLW datasets were supplied by three of the major UK retailers, providing useful details for evaluation. Data sources for manufacturing quantities included environmental permitting data, the European Waste Catalogue, business registers, and public and industry-conducted surveys of businesses.

Positive Impacts: WRAP's *Quantification of Food Surplus, Waste and Related Materials in the Supply Chain* report is the most comprehensive review of surplus food and FLW amounts from the UK food manufactures and grocery retailers. Its research has applied a new approach to estimating avoidable FLW from the food manufacture and retail sectors and sub-sectors and to how the information can be used for various waste prevention interventions. Participation by major food retailers, who provided product-level datasets on FLW, allowed researchers to developed detailed estimates of FLW and of the potential of specific strategies to avoid FLW.

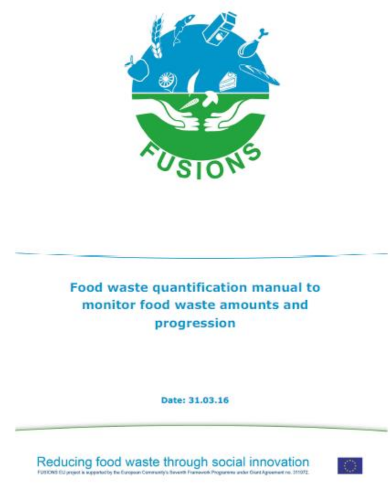
Key Insights: The report highlights that FLW prevention, donation, and diversion to animal feed, by food manufacturers and retail, could reduce avoidable FLW by 42 percent, saving businesses the equivalent of millions of US dollars per year. All of the UK's major grocery retailers, representing more than 90 percent of the UK market, signed onto the Courtauld Commitment. To maintain industry cooperation, WRAP handles data in strict confidence, with robust security measures in place; it shares only aggregated, sector-level estimates. Data are "sense-checked" by WRAP but are not subject to "spot checks" or "on the ground" validation.

Source: WRAP 2016b.

Case Study 35. International: Food Waste Quantification Manual | EU FUSIONS

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

Food Use for Social Innovation by Optimizing Waste Prevention Strategies (FUSIONS) is a collaboration of 21 partners from 13 countries in the European Union as well as 170 European stakeholders across the food supply chain who have committed to reducing FLW. While FUSIONS does not require members and partners to report on their FLW, it encourages member states to measure their FLW levels on a regular basis in order to assess their progress toward UN Sustainable Development Goal 12.3. FUSIONS aims to harmonize FLW measurement definitions and methodologies and to facilitate obtaining data that are more reliable and more consistent and that can be tracked over time.



Source: EC 2016.

FUSIONS' 2016 *Food Waste Quantification Manual to Monitor Food Waste Amounts and Progression* provides guidance on quantifying FLW at different stages of the supply chain, based on the framework of the global standard established by the Food Loss & Waste Protocol. It explicitly defines what "food loss and waste" is and suggests (but does not prescribe) quantification methods that can be used. The manual covers three main activities:

- quantifying FLW in each sector of the food chain;
- combining sectorial quantification, using a common framework at a national level; and
- reporting the results of the national FLW quantification study, at a country level and in a consistent and comparable manner.

Examples of strategies identified for quantifying FLW are presented in TABLE 50.

TABLE 50. FUSIONS Strategy Examples for Quantification Methodologies for Food Loss and Waste

Quantification Method Type	Sector	Example
Use existing data	Primary production (e.g., agriculture)	Use farmer or national records on animals sent to slaughter and animal deaths before slaughter.
Undertake a study involving new measurements	Processing and manufacturing	Use EU Prodcom data to combine FLW percentages with production statistics.
Direct weighing or volumetric assessments	Wholesale, retail and markets	Conduct site visits and waste audits at a sample of locations; scale to national level.
Scanning/counting	Wholesale, retail and markets	Scan packaged food items that are being taken for disposal, so that they are recorded electronically, as part of a stock-keeping system.
Waste composition analysis	Wholesale, retail and markets	Physically separate, weigh and categorize mixed-solid-waste streams that are not compacted and can be accessed.

Quantification Method Type	Sector	Example
Diaries	Foodservice	Log and record what food types are thrown away, and reasons for it.
Surveys	Primary production (e.g., agriculture)	Conduct a confidential survey of a sample of farmers who grow produce representing the top 80% of national production; scale results to non-surveyed farmers to extrapolate national results.
Mass balance	Primary production (e.g., agriculture)	Calculate amount of wheat waste by using data on harvested yields and on imports and subtracting outflows (e.g., amount sold to consumer or as exports)
Models	National organization	Use information on the relationship between the amounts of FLW generated and economic factors, to estimate levels of FLW within an economy.
Proxy data	National organization	Use if information measurement is not feasible due to limited budget or direct access to FLW data, such as amounts of FLW generated by individual sites.

Positive Impacts: The *Quantification Manual* was developed in collaboration with FUSIONS members-state experts and stakeholders, including some team members who had developed the Food Loss and Waste Accounting and Reporting Standard, which provides a globally recognized approach for accounting and reporting standards. The manual is a useful tool that can also be used as a reference by researchers collecting data for national statistical offices and national authorities. Resource Efficient Food and Drink for the Entire Supply Chain (Refresh) is an EU research project that plans to build on the results and experience of the on-going FUSIONS project in order to take further action against FLW. It consists of 26 partners from 12 European countries and China and is funded through 2019 by the Horizon 2020 Framework Programme of the European Union.

Key Insights: Belgium and the UK have already used the FUSIONS *Quantification Manual* to quantify their FLW. At a FUSIONS conference, these countries emphasized that the manual provides a good balance between using common language and methodology, and has the flexibility to use data and strategies that have already been developed.

Sources: EC 2016; WRI 2016.

Case Study 36. International: Mandatory Reporting of Food Waste | Japan

Stage of Food Supply Chain: Post-Harvest, Processing, Distribution, Retail, Foodservice

FLW receives careful attention in Japan, as it used to account for one-fourth of the nation's municipal solid waste stream and has environmental, social and economic impacts. In 2001, Japan enacted the Promotion of Utilization of Recyclable Food Waste Act (Food Recycling Law) to increase the recycling rate of commercial and industrial waste and to decrease food waste and other waste generation. The Food Recycling Law defines FLW as: (1) food materials which are disposed of after being served or without being served as food, and (2) materials which cannot be provided as food and can be obtained as a byproduct in the process of manufacturing processing and cooking by manufacturer, wholesaler, retailer and caterers.

In 2007, the Food Recycling Law was amended to further promote processing FLW into animal feed or fertilizer. The amendment also required food business operators that produce more than 100 tonnes of waste per year to report annually the amount of FLW generated from their manufacturing and distribution processes. Food businesses must also report their recycling efforts to Japan's Ministry of Agriculture, Forestry and Fisheries. If the Japanese government determines that a business' FLW reduction efforts are not sufficient or are out of compliance, the government can provide recommendations and instructions for improvements, publish the name of the company, or impose penalties. The submitted mandatory report responses, in addition to sample surveys for food operators of 100 tonnes or less, are used to estimate FLW for the entire country, for the food operator sectors.

Positive Impacts: The Food Recycling Law raises food business' awareness and actions about the extent of the FLW caused by their business practices. Mandatory reporting for food businesses that generate the largest quantities of waste provides a more robust national estimate of FLW than relying on voluntary reporting alone.

Key Insights: Since the Food Recycling Law was passed, most of the FLW associated with business activities in Japan is now recycled. Japan is heavily dependent on importation of agricultural products and overseas food resources. Its heavy reliance on imports is one of the motivators behind reducing FLW and improving food self-sufficiency: to better protect itself in the event of a potential global food system crisis and its impacts on food insecurity.

Sources: Marra 2013; Parry, Bleazard and Koki 2015.

Appendices

Appendix 1. Definitions

TABLE A1-1. Definitions of Food Loss and Waste

Definition of Food Loss and Waste	Source
- Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed of (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea).	EC (2014)
- Food waste is a component of food loss and occurs when an edible item goes unconsumed, such as food discarded by retailers due to undesirable color or blemishes and plate waste discarded by consumers.	Buzby et al. (2014)
- Food waste is broadly defined as food or edible material (both solid food and liquids) originally meant for human consumption in its entirety (such as fruit and vegetables) or after processing (such as wheat into flour, then bread), but is lost along the food chain. Within the general concept of food waste, a distinction is often made between food loss and food waste.	Uzea et al. (2014)
- Food waste refers to food that is of good quality and fit for human consumption but does not get consumed because it is discarded—either before or after it spoils. Food waste is the result of negligence or a conscious decision to throw food away.	World Resources Institute (2013)
- Food losses occurring at the end of the food chain (retail and final consumption) are rather called food waste, which relates to retailers' and consumers' behavior. "Food" waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in the part of food chains leading to "edible products going to human consumption".	Gustavsson et al. (2011)
- Food and drink waste is categorized by how avoidable it is: - Avoidable – food and drink thrown away that was, at some point prior to disposal, edible (e.g., slice of bread, apples, meat). - Possibly avoidable – food and drink that some people eat and others do not (e.g. bread crusts), or that can be eaten when a food is prepared in one way but not in another (e.g., potato skins). - Unavoidable – waste arising from food or drink preparation that is not and has not been, edible under normal circumstances (e.g., meat bones, egg shells, pineapple skin, tea bags	WRAP (2011)

TABLE A1-2. Definitions of Reduction of Food Loss and Waste

Definition	Source
- Actions [that] prevent wasted food. - Actions that reduce the volume of surplus food generated.	US EPA (2016a)
- Actions that reduce the amount of food loss and waste generated.	Food Waste Reduction Alliance (2015)
- Avoid surplus food generation throughout food production and consumption. - Prevent avoidable food loss and waste generation throughout the food supply chain.	Papargyropoulou et al. (2014)

TABLE A1-3. Definitions of Food Rescue and Recovery

Definition	Source
- Rescue of safe and nutritious food for human consumption: - To receive, with or without payment, food (processed, semi-processed, or raw), which would otherwise be discarded or wasted from the agricultural, livestock, and fisheries supply chains of the food system. - Redistribution of safe and nutritious food for human consumption: - To store or process and then distribute the received food pursuant to appropriate safety, quality, and regulatory frameworks directly or through intermediaries, and with or without payment, to those having access to it for food intake.	WRI (2016)
- Donate extra food to food banks, soup kitchens, and shelters. - Divert food scraps to animal feed.	US EPA (2016a)
- Most people have seen perfectly good food thrown away at a restaurant, bakery, or dinner party and wished there was a way to get it to people in need. Food rescue captures that food and transports it while it is still edible to help address the issue of food insecurity.	ReFED (2016)
- Re-use surplus food for human consumption for people affected by food poverty, through redistribution networks and food banks	Papargyropoulou et al. (2014)
- Food rescue involves accessing extra, excess, or wholesome food rarely called waste at production, distribution, and consumption in order to bring it to people who need or want it. Food rescue can involve gleaning unharvested produce on farms and at markets, re-processing food (for example, making jam with blemished products), or matching the supply of available extra food to the demands of food banks and charities.	Mourad (2016)

Appendix 2. Stakeholders

The following table is intended to be illustrative, and should not be interpreted as an exhaustive list of stakeholders within each country.

TABLE A2-1. Stakeholder List, by Country and Stage of Food Supply Chain

Canada	Mexico	United States	International
Across Food Supply Chain			
- Agriculture and Agri-Food Canada - BC Ministry of the Environment - Canadian Food Inspection Agency - Conference Board of Canada - Deloitte - Environmental and Climate Change Canada - Federation of Canadian Municipalities - Food & Consumer Products of Canada - National Zero Waste Council - Ontario Waste Management Association - Provision Coalition - Sustain Ontario - Statistics Canada - Value Chain Management International	- Agency of Services for Trade and Agri-food and Livestock Development Markets - Agri-food and Fishery Information System - Climate Change and Ecology National Institute - Consumption Product Industry Mexican Council - Federal Attorney for Environmental Protection - Federal Commission of Sanitary Risk Prevention - Institute for Planning Development - International Labor Organization - Mexican Cleaner Production Center - Mexican Transport Institute - Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food - Ministry of Economy - Ministry of the Environment and Natural Resources - Ministry of Social Development - Ministry of Tourism - National Agriculture and Livestock Council - National Service of Agri-food Health Safety and Quality	- American Fruit and Vegetable Processors and Growers Coalition - Biocycle - BSR - CalRecycle - Food and Drug Administration - Food Marketing Institute - Food Waste Reduction Alliance - Harvard Food Law and Policy Clinic - ICF Consulting - National Resources Defense Council - ReFED - Sustainable America - United States Department of Agriculture - United States Environmental Protection Agency	- Commission for Environmental Cooperation - Economic Commission for Latin America and Caribbean - European Commission - Food and Agriculture Organization - The World Bank - United Nations Environment Programme - Waste and Resources Action Programme - World Resources Institute - World Wildlife Fund

<table>
<tr><th>Canada</th><th>Mexico</th><th>United States</th><th>International</th></tr>
<tr><td></td><td>- Simapro Bajío
- Simapro Chihuahua</td><td></td><td></td></tr>
<tr><td colspan="4">Post-Harvest Food Production</td></tr>
<tr><td>- Agropur Cooperative
- BC Tree Fruits
- Canadian Federation of Agriculture
- Canadian Grain Council
- Canadian Meat Council
- Fisheries Council of Canada
- RedHat Cooperative
- Village Farms International
- Viterra Inc.</td><td>- International Maize and Wheat Improvement Center
- Mexican Avocado Producers and Packers Association
- Mexican Meat Council
- National Chamber of Fish and Aquaculture Industry
- National Chamber of Industrialized Corn
- National Chamber of Milk Industry
- National Council of Mango Producers
- National Council of Tomato Producers</td><td>- American Farm Bureau Federation
- Church Brothers
- Harris Ranch
- Innovation Center for U.S. Dairy
- National Corn Growers Association
- National Farmers Union</td><td>- Del Monte Foods, Inc.
- Dole Food Company, Inc.</td></tr>
<tr><td colspan="4">Processing and Manufacturing</td></tr>
<tr><td>- Canadian Council of Food Processors
- Dare Foods Ltd.
- Food & Beverage Canada
- Food Processors of Canada
- Maple Leaf Foods Inc.
- McCain Foods Canada
- National Renderers Association
- Pride Pack
- Redpath Sugar
- Small Scale Food Processors Association
- VG Meats
- Weston Foods</td><td>- Bachoco
- Bimbo
- Grupo Herdez
- Grupomar
- Industry Transformation National Chamber – Food Sector
- La Nueva Viga
- Mexican Association of Food Producers
- National Association of Food for Animal Consumption
- National Association of Packers Type Tif
- National Chamber of Bread Industry
- National Chamber of Canned Food
- National Chamber of Preserves</td><td>- The Association for Packaging and Processing Technologies
- American Frozen Food Institute
- Cargill, Inc.
- ConAgra Brands Inc.
- The Food Institute
- Grocery Manufacturers Association
- National Food Processors Association
- National Renderers Association
- Tyson Foods, Inc.</td><td>- Campbell Soup Company
- The Coca-Cola Company
- General Mills, Inc.
- Global Food Cold Chain Council
- International Foodservice Distributors Association
- Kellogg Co.
- Kraft Foods Inc.
- International Foodservice Manufacturers</td></tr>
</table>

Canada	Mexico	United States	International
	- National Chamber of Wheat Miller Industry - National Council of Producers of Balanced Food and Animal Nutrition - Productos Pisícolas Río Balsas		Association - Nestlé S.A. - PepsiCo, Inc. - Proctor & Gamble Co. - Unilever Group
Distribution			
- Colabor - Flanagan Foodservice - Fresh Point - Gordon Food Service - National Food Distributors Association - Packaging Association of Canada - Stewart Foodservice Inc.	- Chamber of National Load Transport - Distribution System of CONASUPO - National Association of Importers and Exporters of Mexican Republic - National Association of Private Transport - National Confederation of Traders and Supply Centers in Mexico - National Council of Assembly and Exportation Industry	- Food Services America - Fresh Point - Gordon Food Service - National Poultry & Food Distributors Association - Robinson Fresh - U.S. Foods	- Global Food Cold Chain Council - International Foodservice Distributors Association - Sysco
Retail			
- Canadian Federation of Independent Grocers - Loblaw Companies Limited - Metro Inc. - Overwaitea Foods - Retail Council of Canada - Safeway - Sobeys Inc. - Whole Foods Market	- Central Supply Market Association - Chedraui - Comercial Mexicana - Market Medellin - National Association of Self Service Stores - Soriana	- Ahold USA - Albertsons/Safeway - Giant Food - The Kroger Co. - National Grocers Association - Publix Super Markets - Wegmans - Whole Foods Market	- Costco Wholesale Corporation - Wal-Mart Stores, Inc.
Foodservice			
- A&W - Aramark	- Hotels Association in Riviera Nayarit - La Posta	- Aramark - Bon Appétit Management	- Chipotle Mexican

Canada	Mexico	United States	International
- Browns - Compass Group - Darden Restaurants - Neighbourhood Group of Companies - Restaurants Canada - Tim Hortons	- Le Bon Goût - Mexican Association of Hotels and Motels - Mexican Restaurant Association - National Chamber of Restaurant Industry and Spiced/Seasoned Food - Restaurants Association in Riviera Nayarit	Company - Compass Group - Darden Restaurants - National Restaurant Association - Sodexo	Grill - Four Seasons Hotels and Resorts - Marriott International - McDonald’s Corporation - Starbucks Corporation
Food Rescue and Distribution Organizations			
- Food Banks Canada - Greater Vancouver Food Bank - Moisson Montréal - Second Harvest	- Alimentos Para Todos IAP - Food Bank of the Central Supply Market of Mexico City - Food Banks of Mexico - The Hunger Project Mexico	- City Harvest - Feeding America - Food Cowboy - Food Recovery Network	- The Global FoodBanking Network

Appendix 3. Food Loss and Waste Quantification Methodology

Food loss and waste (FLW) for each country was quantified using a combination of food production data and loss factors from the FAO and other sources. First, food production estimates from each country were obtained from FAO's Food Balance Sheets for Canada, Mexico and the United States for the year 2007, to align with the data used by a study conducted by Gustavsson et al. (2011). The methodology for the study was documented in Gustavasson (2013). The methodology of the study has been adapted slightly to meet the requirements of North American FLW analysis, namely to include the inedible fractions of FLW as part of the calculation.

Regional loss factors from Gustavsson et al. (2013) were applied to each stage of the food supply chain to estimate FLW by product type (edible and inedible). Loss factors are the fraction of food that is lost at each stage of the food supply chain. North America and Oceania factors were used for Canada and the United States (Table A3-1). Latin America factors were used for Mexico (Table A3-2).

TABLE A3-1. **Loss Factors for Food Supply Chain in Canada and the United States**

Product	Stage of the Food Supply Chain				
	Food Production Pre-Harvest	Food Production Post-Harvest	Processing and Packaging	Distribution	Consumption
Cereals	0.02	0.02	0.005 (m) 0.1 (p)	0.02	0.27
Roots and Tubers[1]	0.2	0.1	0.15	0.07 (f) 0.03 (p)	0.3 (f) 0.12 (p)
Oilseeds and Pulses	0.12	0	0.05	0.01	0.04
Fruits and Vegetables[2]	0.2	0.04	0.02	0.12 (f) 0.02 (p)	0.28 (f) 0.1 (p)
Meat	0.037	0.01	0.05	0.04	0.11
Fish and Seafood[3]	0.12	0.005	0.06	0.09 (f) 0.05 (p)	0.33 (f) 0.1 (p)
Milk	0.035	0.005	0.012	0.005	0.15
Eggs	0.04	-[4]	0.005	0.02	0.15

[1] 27% of product used fresh, remaining is processed.
[2] 40% of product used fresh, remaining is processed.
[3] 4% of product used fresh, remaining is processed.
[4] No data.
Note: Loss factors are the fraction of food that is lost at each stage of the food supply chain. (m) = milled; (p) = processed; (f) = fresh.
Source: Based on regional loss factors from Gustavsson et al. 2013.

TABLE A3-2. **Loss Factors for Food Supply Chain in Mexico**

Product	Stage of the Food Supply Chain				
	Food Production Pre-Harvest	**Food Production Post-Harvest**	**Processing and Packaging**	**Distribution**	**Consumption**
Cereals	0.06	0.04	0.02 (m) 0.07 (p)	0.04	0.1
Roots and Tubers[1]	0.14	0.14	0.12	0.03 (f) 0.03 (p)	0.04 (f) 0.02 (p)
Oilseeds and Pulses	0.06	0.03	0.08	0.02	0.02
Fruits and Vegetables[2]	0.20	0.10	0.20	0.12 (f) 0.02 (p)	0.10 (f) 0.01 (p)
Meat	0.056	0.011	0.05	0.05	0.06
Fish and Seafood[3]	0.057	0.05	0.09	0.10 (f) 0.05 (p)	0.04 (f) 0.02 (p)
Milk	0.035	0.06	0.02	0.08	0.04
Eggs	0.06	-[4]	0.005	0.04	0.04

[1] 20% of product used fresh, remaining is processed.
[2] 50% of product used fresh, remaining is processed.
[3] 60% of product used fresh, remaining is processed.
[4] No data.
Note: Loss factors are the fraction of food that is lost at each stage of the food supply chain. (m) = milled; (p) = processed; (f) = fresh.
Source: Based on regional loss factors from Gustavsson et al. 2013.

Allocation factors were applied to estimate the fraction for human consumption of each product type. Conversion factors were applied to estimate the food (edible) fraction of each product type. Allocation and conversion factors were not provided by Gustavsson et al. (2013) for all types of food products. Therefore, there are data gaps in estimating the food fraction of meat, milk and eggs, as they are currently all considered to be food (i.e., no inedible parts). Allocation and conversion factors are presented in Table A3-3.

TABLE A3-3. **Allocation and Conversion Factors**

Product	Canada and United States	Mexico
Cereals	Allocation: 0.50 Conversion[1]	Allocation: 0.40 Conversion[2]
Roots and Tubers	Allocation: Not applicable, assumed all for human consumption Conversion: Peeling by hand, 0.74; industrial peeling, 0.90	
Oilseeds and Pulses	Allocation: 0.17 Conversion: Not available	Allocation: 0.12 Conversion: Not available
Fruits and Vegetables	Allocation: Not applicable, assumed all for human consumption Conversion: Peeling by hand, 0.8; industrial peeling, 0.75	
Meat	Not available	
Fish and Seafood	Allocation: Not applicable, assumed all for human consumption Conversion: 0.5	
Milk	Not available	
Eggs	Not available	

[1] Conversion factors are specific to sub-product: wheat, rye = 0.78; maize, millet, sorghum = 0.69; rice = 1; oats, barley, other cereals = 0.78

[2] Conversion factors are specific to sub-product: wheat, rye = 0.78; maize, millet, sorghum = 0.79; rice = 1; oats, barley, other cereals = 0.78

Source: Based on allocation and conversion factors from Gustavsson et al. 2013.

The equations used for the estimates at each stage of the food supply chain are presented in Table A3-4. Different sets of equations were used, depending on the product type (Gustavsson et al. 2013). The equations to estimate the edible fraction of FLW are presented in Table A3-5. An example calculation for fruits and vegetables in Canada is shown below the tables.

The variables for Tables A3-4 and A3-5 are defined as follows:

- Inputs from Food Balance Sheets (available for download from FAOSTAT, FAO 2017):
    - P = production quantity (by weight)
    - F = food for human consumption (by weight)
    - R = processed food for human consumption, that contains multiple types of products (by weight)
- e = fraction utilized fresh
- C = the conversion factor for a product
- c = the conversion factor for a sub-product
- a = the allocation factor for a product
- E = quantity utilized fresh ($E = F * e$)
- S = quantity utilized processed ($S = F * (1 - e)$)
- M = milled quantity ($M = \sum[c_j * F_j]$ where j is the sub-product)
- L_x = the loss factor for stage x
- FLW_x = the FLW (in 1000 tonnes) for stage x

TABLE A3-4. Equations for Calculations of Food Loss and Waste, Including Inedible Parts

Food Supply Chain Stage	Cereals	Oilseeds and Pulses	Roots and Tubers, Fruits and Vegetables, Fish and Seafood	Meat, Milk, Eggs
Food Production Pre-Harvest (pre)	$FLW_{pre} = \frac{L_{pre}}{1 - L_{pre}} * P * a$	$FLW_{pre} = \frac{L_{pre}}{1 - L_{pre}} * P * a$	$FLW_{pre} = \frac{L_{pre}}{1 - L_{pre}} * P$	$FLW_{pre} = \frac{L_{pre}}{1 - L_{pre}} * P$
Food Production Post-Harvest ($post$)	$FLW_{post} = L_{post} * P * a$	$FLW_{post} = L_{post} * P * a$	$FLW_{post} = L_{post} * P$	$FLW_{post} = L_{post} * P$
Processing ($proc$)	$FLW_{mill} = L_{mill} * F$ $FLW_{proc} = FLW_{mill} + L_{proc} * (M + R - FLW_{mill})$	$FLW_{proc} = L_{proc} * (R + F)$	$FLW_{proc} = L_{proc} * (R + S)$	$FLW_{proc} = L_{proc} * (R + F)$
Distribution ($dist$)	$FLW_{dist} = L_{dist} * (M + R - FLW_{proc})$	$FLW_{dist} = L_{dist} * (F + R - FLW_{proc})$	$FLW_{dist,fresh} = L_{dist,fresh} * E$ $FLW_{dist,proc} = L_{dist,proc} * (S + R - FLW_{proc})$ $FLW_{dist} = FLW_{dist,fresh} + FLW_{dist,proc}$	$FLW_{dist} = L_{dist} * (F + R - FLW_{proc})$
Consumption ($cons$)	$FLW_{cons} = L_{cons} * (M + R - FLW_{proc} - FLW_{dist})$	$FLW_{cons} = L_{cons} * (F + R - FLW_{proc} - FLW_{dist})$	$FLW_{cons,fresh} = L_{cons,fresh} * (E - FLW_{dist,fresh})$ $FLW_{cons,proc} = L_{cons,proc} * (S + R - FLW_{proc} - FLW_{dist,proc})$ $FLW_{cons} = FLW_{cons,fresh} + FLW_{cons,proc}$	$FLW_{cons} = L_{cons} * (F + R - FLW_{proc} - FLW_{dist})$

Source: Gustavsson et al. 2013.

TABLE A3-5. Equations for Subtracting Inedible Parts from Food Loss and Waste Calculations

Food Supply Chain Stage	Cereals	Oilseeds and Pulses	Roots and Tubers, Fruits and Vegetables, Fish and Seafood	Meat, Milk, Eggs
Food Production Pre-Harvest (pre)	All assumed edible	All assumed edible	$FLW_{pre,ed} = FLW_{pre} * \frac{C_{hand} + C_{ind}}{2}$	All assumed edible
Food Production Post-Harvest ($post$)	All assumed edible	All assumed edible	$FLW_{post,ed} = FLW_{post} * \frac{C_{hand} + C_{ind}}{2}$	All assumed edible
Processing ($proc$)	All assumed edible	All assumed edible	$FLW_{proc,ed} = FLW_{proc} * C_{ind}$	All assumed edible
Distribution ($dist$)	All assumed edible	All assumed edible	$FLW_{dist,fresh,ed} = FLW_{dist,fresh} * C_{hand}$ $FLW_{dist,proc,ed} = FLW_{dist,proc} * C_{ind}$ $FLW_{dist,ed} = FLW_{dist,fresh,ed} + FLW_{dist,proc,ed}$	All assumed edible
Consumption ($cons$)	All assumed edible	All assumed edible	$FLW_{cons,fresh,ed} = FLW_{cons,fresh} * C_{hand}$ $FLW_{cons,proc,ed} = FLW_{cons,proc} * C_{ind}$ $FLW_{cons,ed} = FLW_{cons,fresh,ed} + FLW_{cons,proc,ed}$	All assumed edible

Source: Gustavsson et al. 2013.

A3.1 Example Calculation of Fruits and Vegetables Lost and Wasted in Canada

This example calculation shows how the quantity of fruits and vegetables lost and wasted in Canada was calculated, using the FAO methodology (Gustavsson et al. 2013) and using the formulas, loss factors, conversion factors and allocation factors presented in Tables A3-1 to A3-5. Units are in million tonnes.

Pre-Harvest:

$$FLW_{pre} = \frac{L_{pre}}{1 - L_{pre}} * P = \frac{0.2}{1 - 0.2} * 3.324 = 0.831$$

Food only:

$$FLW_{pre,ed} = FLW_{pre} * \frac{C_{hand} + C_{ind}}{2} = 0.831 * \frac{0.8 + 0.75}{2} = 0.644$$

Post-Harvest:

$$FLW_{post} = L_{post} * P = 0.04 * 3.324 = 0.133$$

Food only:

$$FLW_{post,ed} = FLW_{post} * \frac{C_{hand} + C_{ind}}{2} = 0.133 * \frac{0.8 + 0.75}{2} = 0.103$$

Processing:

$$S = F * (1 - e) = 8.753 * (1 - 0.4) = 5.252$$

$$FLW_{proc} = L_{proc} * (R + S) = 0.02 * (0.072 + 5.252) = 0.106$$

Food only:

$$FLW_{proc,ed} = FLW_{proc} * C_{ind} = 0.106 * 0.75 = 0.080$$

Distribution:

$$E = F * e = 8.753 * 0.4 = 3.501$$

$$FLW_{dist,fresh} = L_{dist,fresh} * E = 0.12 * 3.501 = 0.420$$

$$FLW_{dist,proc} = L_{dist,proc} * \left(S + R - FLW_{proc}\right) = 0.02 * (5.252 + 0.072 - 0.106) = 0.104$$

$$FLW_{dist} = FLW_{dist,fresh} + FLW_{dist,proc} = 0.420 + 0.104 = 0.524$$

Food only:

$$FLW_{dist,fresh,ed} = FLW_{dist,fresh} * C_{hand} = 0.420 * 0.80 = 0.336$$

$$FLW_{dist,proc,ed} = FLW_{dist,proc} * C_{ind} = 0.104 * 0.75 = 0.078$$

$$FLW_{dist,ed} = FLW_{dist,fresh,ed} + FLW_{dist,proc,ed} = 0.336 + 0.078 = 0.414$$

Consumption:

$FLW_{cons,fresh} = L_{cons,fresh} * (E - FLW_{dist,fresh}) = 0.28 * (3.501 - 0.420) = 0.863$

$$FLW_{cons,proc} = L_{cons,proc} * (S + R - FLW_{proc} - FLW_{dist,proc})$$
$$= 0.1 * (5.252 + 0.072 - 0.106 - 0.104) = 0.511$$

$FLW_{cons} = FLW_{cons,fresh} + FLW_{cons,proc} = 0.863 + 0.511 = 1.374$

Food only:

$FLW_{cons,fresh,ed} = FLW_{cons,fresh} * C_{hand} = 0.863 * 0.80 = 0.690$

$FLW_{cons,proc,ed} = FLW_{cons,proc} * C_{ind} = 0.511 * 0.80 = 0.409$

$FLW_{cons,ed} = FLW_{cons,fresh,ed} + FLW_{cons,proc,ed} = 0.690 + 0.409 = 1.099$

Appendix 4. Methodology for Calculation of Greenhouse Gas Emissions

A4.1 Methane Emissions

The Intergovernmental Panel on Climate Change (IPCC) uses a first-order decay method to estimate methane emissions, which occur as the degradable organic carbon in landfilled materials decays slowly over a few decades (Pipatti and Svardal 2006). This equation was adapted to estimate the total methane emissions (over a 50-year period, by the end of which most of the methane would have been emitted) from FLW disposed of in a single year. The equation is provided below.

$$A = \left[\sum_{x=0}^{50} \left\{ WL' \left(e^{-k(x-1)} - e^{-kx} \right) \right\} \right] * (1 - c)$$

where

A = net CH_4 generation (million tonnes over 50 years)

x = year

W = the quantity of FLW disposed of in landfills (million tonnes/year)

k = decay rate constant (yr^{-1})

L' = calculated CH_4 generation potential (tonne CH_4 / tonne FLW) = $MCF * DOC * DOC_f * F * 1.33$

MCF = CH_4 correction factor (unitless), typically 1 for managed landfills

DOC = degradable organic carbon (unitless)

DOC_f = decomposable fraction of DOC (unitless), generally assumed to be 0.5

F = fraction, by volume, of CH_4 in landfill gas (unitless), generally assumed to be 0.5

c = landfill gas capture rate (%)

Sources: Adapted from US EPA 2010; Pipatti and Svardal 2006.

This model contains region-specific default emission factors and uses inputs from country-level data, such as the quantity of FLW disposed of in landfills and the percent of methane gas captured. Inputs to the IPCC model, by country, are provided in Table A4-1 for the current (status quo) scenario. For other scenarios, the quantity of FLW disposed of in landfills (W) was reduced, as shown in Table 39, in the main body of the report.

TABLE A4-1. Inputs to the IPCC Methane Gas Emissions Model

Parameter Notation	Parameter Description	Canada	Mexico	United States
Region (corresponding IPCC region)		North America	Central America	North America
DOC	Degradable organic fraction for FLW	0.15	0.15	0.15
DOC_f	Decomposable fraction of DOC	0.5	0.5	0.5
k	Methane generation rate constant for FLW	0.19	0.4	0.19
F	Fraction of methane in Developed Gas	0.5	0.5	0.5
-	Conversion factor from C to CH_4	1.33	1.33	1.33
MCF	Methane correction factor for managed landfills	1	1	1
W	Quantity of FLW disposed of in landfill (million tonnes/year)	4.3 (NZWC 2017)	8.8[1]	26.6 (US EPA 2016c)
x	Year	Started as 0 and ended at 50		
-	Methane gas captured	28% (ICF Consulting 2005, 70)[2]	0%[3]	52% (US EPA 2015b, 7–14)

[1] Methodology found in Section A4.1.1.
[2] 75% capture efficiency at 37% of landfills.
[3] No data available on average capture rate, conservatively assumed to be zero.

A4.1.1 Landfilled Food Loss and Waste Calculation for Mexico

Mexico does not have a reported quantity of FLW disposed of in landfills. Therefore, a calculation methodology was developed for this report by combining data on municipal solid waste (MSW) generation and waste composition analysis.

MSW data were obtained from INEGI (2013):

- 43 million tonnes MSW generated in 2013 (MSW)
- 66.4% of MSW is landfilled (f_l)

Only landfilled FLW is included in the methane emissions calculations. Therefore, the landfilled MSW (MSW_l) was calculated as follows:

$$MSW_l = MSW * f_l = 28.6 \text{ million tonnes/year}$$

To estimate the quantity of FLW in landfilled MSW, the average percentage of FLW (p_{flw}=31%) was obtained from the GMI's Mexico Landfill Gas Model (Table A4-2). FLW in landfills (FLW_l) was calculated as follows:

$$FLW_l = MSW_l * p_{flw} = 8.8 \text{ million tonnes/year}$$

TABLE A4-2. Statewide Waste Characterization Data in Mexico

State	FLW in MSW (%)
Aguascalientes	45
Baja California North	36
Baja California South	31
Campeche	31
Chiapas	31
Chihuahua	26
Coahuila	35
Colima	26
Distrito Federal	12
Durango	31
Guanajuato	37
Guerrero	26
Hidalgo	35
Jalisco	26
México	39
Michoacán	34
Morelos	26
Nayarit	26
Nuevo León	39
Oaxaca	26
Puebla	30
Querétaro	30
Quintana Roo	38
San Luis Potosí	31
Sinaloa	23
Sonora	30
Tabasco	31
Tamaulipas (except Tampico)	34
Average	**31**

A4.2 Life-Cycle Greenhouse Gas Emissions

The WaRM tool was used to estimate life-cycle greenhouse gas (GHG) emissions for Mexico and the United States. For Canada, the WaRM tool was used for upstream emissions and the Canadian GHG calculator was used for downstream emissions. The assumptions for each country set in WaRM (or the Canadian GHG calculator) are provided in Table A4-3. Default values for the United States were used for Mexico, due to the lack of country-specific data. Scenario inputs for the quantity of FLW landfilled versus source-reduced are provided in Table 39, in the main body of the report.

TABLE A4-3. Life-Cycle Greenhouse Gas Emissions Estimation Assumptions Inputted to WaRM or Canada GHG Calculator Tools[1]

Assumption	Canada	Mexico	United States
Electricity-Related Emission Factors	Canadian national average	US national average	US national average
Landfill Gas Capture	Canadian national average	No capture assumed[2]	US national average
Landfill Gas Capture Usage	Recover for energy	Not available	Recovery for energy
Landfill Gas Collection Efficiency	Typical operation	Not available	Typical operation
Moisture Conditions for Decay Rate	Canadian national average	US national average	US national average
Transport Distances	Default distances	Default distances	Default distances

[1] Underlying assumptions and emission factors are provided in the US EPA's WaRM documentation (US EPA 2015b) and the Canada GHG Calculator documentation (ICF Consulting 2005). The exact emission factors themselves are not required, to use the tools, just the settings as specified in this table.

[2] This is a conservative estimate. There are landfills with gas capture in Mexico, but data on the quantity of methane gas captured were not readily available.

A4.3 Scenario Calculations

Avoided methane emissions were calculated by multiplying the methane generation rate from Table 39, with the quantities of FLW avoided from landfill disposal specified in Table 40.

The values generated from this multiplication exercise are presented in Table A4-4.

TABLE A4-4. Methane Emissions for FLW Reduction Scenarios

Parameter	Canada	Mexico	United States
Methane Gas Generation Rate from Landfilled FLW (tonnes methane/ tonne FLW)	0.04	0.05	0.02
FLW Avoided from Landfill Disposal for High Implementation (50% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice) (million tonnes/year)	1.6	6.4	14.7
Net Methane Gas Avoided from Landfilled FLW for High	0.04*16 = 0.06	0.05*6.4=0.32	0.02*14.7=0.35

Parameter	Canada	Mexico	United States
Implementation (million tonnes/ year)			
FLW Avoided from Landfill Disposal for Limited Implementation (20% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice) (million tonnes/year)	0.6	2.5	5.9
Net Methane Gas Avoided from Landfilled FLW for Limited Implementation (million tonnes/ year)	0.04*0.6=0.02	0.05*2.5=0.13	0.02*14.7=0.14

Avoided GHG emissions were calculated by changing the inputted quantities of landfilled FLW in WaRM or the Canada GHG Calculator, as presented in Table A4-5. The assumptions used were the same as those in Table A4-3.

TABLE A4-5. Scenario Inputs to WaRM or Canada GHG Calculator

Parameter	Canada	Mexico	United States
FLW Avoided from Landfill Disposal for High Implementation (50% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice) (million tonnes/year)	1.6	6.3	14.7
FLW Disposed of in Landfill for High Implementation (million tonnes/year)	2.7	2.5	11.9
GHG Emissions Avoided from Reducing Landfilled FLW for High Implementation (million tonnes CO_2e/ year)	7.7	35.3	68.1
FLW Avoided from Landfill Disposal for Limited Implementation (20% of Baseline Edible in Post-Harvest/Distribution/Retail/Foodservice) (million tonnes/year)	0.6	2.5	5.9
FLW Disposed in Landfill for Limited Implementation (million tonnes/year)	3.7	6.3	20.7
GHG Emissions Avoided from Reducing Landfilled FLW for Limited Implementation (million tonnes CO_2e/ year)	3.1	14.1	27.3

Appendix 5. Background Information on Landfill Gas Capture

A5.1 Canada

While overall emissions from the waste sector in Canada have increased since 1990, the proportion of landfill gas captured and combusted had increased by 134% by 2014 (Environment and Climate Change Canada 2016). By 2014, 49% of captured methane was combusted for energy, with the remainder flared. In 2012, it was reported that 64 facilities in Canada were capturing landfill gas (Environment and Climate Change Canada 2012). Typically, the age, size, location and type of landfill determine the type of capture system implemented for landfill gas. Regulations are managed at provincial rather than at the national level. Provinces have varying legislation, aiming for diverting organic waste from landfills and/or installing landfill gas management systems for large landfills or those that produce the largest amounts of methane (Environment and Climate Change Canada 2016).

No Capture of Landfill Gas

Historical landfill sites in Canada are typically not retrofitted with technology for capture of landfill gas. In most jurisdictions, contemporary landfill enclosure includes construction or installation of a barrier layer to minimize landfill gas and leachate production by managing surface water infiltration into the waste mass.

Passive Gas Collection and Venting

Passive gas collection and venting is typically conducted when the rate of methane generation from landfills does not warrant active capture. Passive collection mitigates environmental and safety concerns over lateral migration of landfill gas. Passive systems are highly influenced by local environmental conditions, such as barometric pressure, which affects their efficiency and effectiveness. Venting has been historically used in sites where uncontrolled releases or lateral migration of gasses pose safety concerns. Venting is used when the methane concentration is too low for flaring. Other treatment options are available but sparsely used; they include biofilters and chemical treatment.

Active Capture with Flaring

Collection systems with flaring are typically employed at landfills where emitted gasses or vapors pose safety and environmental risks. Active systems pull gas out of the landfill and flare systems thermally treat the landfill gas, removing most organic compounds and converting methane to carbon dioxide. In 2003, a reported 28 of the 44 sites with installed landfill gas collection used flaring systems. However, the amount collected accounted for less than 50% of the total methane generated in all 44 sites (Jackson 2005).

Active Capture for Other Uses—Compressed Natural Gas, Cogeneration, Greenhouses

Systems are the same as active capture with flaring, but use of gas depends highly on the volume produced and the methane content of that gas. Beneficial uses of landfill gas include natural gas vehicle fuel (compressed natural gas) for generation of electricity and for heating. In 2003 a reported seven of the 44 sites with installed landfill gas collection had direct utilization of the gas, including for heating buildings, providing fuel for manufacturing, and providing fuel for heating. An additional nine sites generated electricity through the use of reciprocating engines, power boilers and steam turbines. These sites accounted for more than 50% of the total methane generated from disposal (Jackson 2005).

Bioreactor landfills

Bioreactor landfills accelerate methane generation by providing favorable microbial conditions through leachate circulation (Perera et al. 2015). The high volume of landfill gas produced, with its high methane concentration, is ideal for utilization of the gas as a replacement for fossil fuels in vehicles, or directly in electricity generation. Only a limited number of bioreactor landfills are currently in operation, and they are primarily pilot and proof-of-concept models.

A5.2 Mexico

Of the three categories of solid-waste disposal sites, as defined by INEGI, only landfills may include more-formal infrastructure for the control of environmental impacts, whereas controlled and uncontrolled dumpsites are illegal and do not comply with the NOM-083-SEMARNAT-2003 standard.[9] Roughly 12.7 percent of the disposal sites in Mexico in 2010 were classified as landfills, and over 66 percent of municipal solid waste (MSW) was disposed of in landfills (Semarnat 2013). There are no data available that delineate the exact number of disposal sites that have infrastructure for methane capture, flaring and/or energy production; however, projects relating to biogas capture have been reported by the Ministry of the Environment and Natural Resources (*Secretaría del Medio Ambiente y Recursos Naturales*—Semarnat) in the White Book of the Program for Waste Prevention and Integral Management 2006–2012. In the Global Methane Initiative (GMI) white paper, 26 landfills were identified as having some form of landfill gas flaring, capture or venting for energy recuperation (Bergua et al. 2016).

A5.3 United States

The United States has highly developed landfill gas collection and capture legislation. Federal tax credits and regulatory requirements have increased the proportion of landfills with landfill gas collection and landfill gas-to-energy systems (US EPA 2013). Landfills are required to be large—having a design capacity of 2.5 million tonnes or more—to collect and combust landfill gas (US EPA 2015b). In the United States, there are approximately 2,400 landfills for municipal solid waste that are either active or closed.

No Capture of Landfill Gas

In 2013, approximately 895 sites had no landfill gas collection (US EPA 2013). Sites with no landfill gas collection are small enough to fall below federal regulatory standards.

Passive Gas Collection and Venting

Passive gas collection and venting are typically conducted when the rate of methane generation from landfills does not warrant active capture. Passive collection mitigates environmental and safety concerns over lateral migration of landfill gas. Passive systems are highly influenced by local environmental conditions, such as barometric pressure, which affects their efficiency and effectiveness. Venting has been historically used in sites where uncontrolled releases or lateral migrations of gasses pose safety concerns.

Active Capture with Flaring

In 2013 approximately 570 sites had landfill gas collection coupled with flaring or venting (US EPA 2013). Flaring treats gasses, converting methane to carbon dioxide, and removes most noxious odours.

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[9] This standard contains specifications of environmental protection for site selection, design, construction, operation, monitoring, closing and complementary constructions of a final disposition site for municipal and special waste.

Active Capture for Other Uses—Compressed Natural Gas, Cogeneration, Greenhouses

In 2013, approximately 165 sites had landfill gas collection coupled with energy production (US EPA 2013). Potential landfill gas utilization includes direct offset of other fuels, typically fossil fuels. Landfill gas has been incorporated into natural gas pipelines. Other innovative landfill gas projects include conversion to vehicle fuels, such as compressed natural gas, and future projects for conversion to liquefied natural gas (US EPA 2015b).

Bioreactor Landfills

Bioreactor landfills (defined in Section 6.3) in the United States, like in Canada, are primarily constructed as proof-of-concept and research facilities. The US EPA supports a Project XL bioreactor pilot project program to develop bioreactor technology. As of 2001, 51 projects had been implemented (US EPA 2016d).

Appendix 6. Quantification Methodologies for Environmental and Socio-Economic Impacts

TABLE A6-1. Global Studies on the Environmental and Socio-Economic Impacts of Food Loss and Waste

Study	Impact Categories Included	Methodology
Food Wastage Footprint: Impacts on Natural Resources (FAO 2013)	- Carbon footprint - Water use - Land occupation/degradation impact - Potential biodiversity impact	Food wastage volumes were determined from Gustavsson et al. (2011). Carbon footprint was determined by food product life-cycle assessments, which include the agricultural phase, on-farm energy use, and non-energy-related emissions. Water use was determined by using the global standard on water footprint assessment, developed by the Water Footprint Network (WFN). Land occupation was described as the surface area of land (including grassland and cropland) that produces food that goes uneaten. Biodiversity impact indicators were chosen at the ecosystem/production level and species level, and at the mean trophic levels for fisheries.
Food Wastage Footprint: Full-Cost Accounting (FAO 2014)	- GHG emissions - Ammonia emissions - Water quality, use and scarcity - Soil erosion - Land occupation - Biodiversity loss from pollutants - Fisheries overexploitation - Pollinator losses - Loss of livelihood - Individual health damage - Pesticide poisoning - Conflict - Economic value of wasted food - Subsidies wasted	Monetized external costs associated with the environmental and socio-economic impacts of FLW on a global scale. The monetary values were assigned by using a combination of direct financial costs (e.g., prices paid for food) and non-market-based valuation for environmental or social conditions where no markets exist or that have no price (e.g., clean air, health damage).
"Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertilizer use" (Kummu et al. 2012)	- Water use - Cropland use - Fertilizer use	Computed total blue-water footprint, cropland and fertilizer use for the domestic food supply quantity, following a similar method to that of Gustavsson et al. (2011). Water, cropland and fertilizer use associated with FLW were calculated by applying the relative proportion of food loss and waste, by stage of the supply chain, to each of the total quantities from the domestic food supply quantity.

Study	Impact Categories Included	Methodology
"Economic valuation of environmental costs of soil erosion and the loss of biodiversity and ecosystem services caused by food wastage" (Schwegler 2014)	- Soil erosion - Pesticide use (Intensification) - Land use	Extensive literature review was conducted to determine the appropriate environmental indicators and their quantities (e.g., soil erosion rates, pesticide inputs, land-use changes, etc.) for select countries. Costs associated with each indicator were calculated by monetizing each indicator (e.g., equivalent cost per unit value), then extrapolated based on the above quantities.

TABLE A6-2. Canadian Studies on the Economic Impacts of Food Loss and Waste

Study	Impact Categories Included	Methodology
$27 Billion Revisited: The Cost of Canada's Annual Food Waste (Gooch et al. 2010; Gooch et al. 2014)	- Economic value of wasted food	Used data from Statistics Canada, a variety of studies, and communications with various industries, to estimate an average dollar amount per person for each sector, for wasted food. Dollar values were multiplied by relevant Canadian populations. Used source data from FAO, USDA and other reports to extrapolate the true cost of FLW from the initial value.
"The Importance of Quantifying Food Waste in Canada" (Abdulla et al. 2013)	- Economic value of wasted food - Food wastage per person - Food availability per person	Used secondary data from Statistics Canada for food availability over a period of 48 years (1961–2009). Food availability adjusted for waste was calculated using estimated "waste factors" provided by the USDA. Compared food availability against food availability adjusted for waste data from Statistics Canada to determine the food wastage per person.

TABLE A6-3. American Studies in the Environmental and Socio-Economic Impacts of Food Loss and Waste

Study	Impact Categories Included	Methodology
The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States (Buzby et al. 2014)	- Economic value of wasted food - Caloric value of wasted food	Used the USDA's Economic Research Service (ERS) Loss-Adjusted Food Availability (LAFA) data sets, which are derived from ERS per-capita Food Availability data. Food loss assumptions for the LAFA data series were used to determine the food loss at retail and consumer levels for over 200 agricultural products.
"The Progressive Increase of Food Waste in America and its Environmental Impact" (Hall et al. 2009)	- Average adult body weight - Food availability per capita - Energy content of FLW per capita - % of available food energy wasted	Quantified the impact of FLW using a mathematical model of human energy expenditure to calculate the average increase in food intake since 1974 versus the average increase in adult body weight.
A Roadmap to Reduce US Food Waste by 20 Percent (ReFED 2016)	- Economic value of wasted food - Job creation potential from rescue and recovery - Quantity of wasted food - GHG reductions - Water conservation	Defined an FLW baseline from a combination of data from primary sources, surveys and modeling. Developed a Marginal Food Waste Abatement Cost Curve, to evaluate solutions. Economic value and landfill diversion potential were the driving evaluation criteria. Also quantified non-financial impacts such as GHG emissions, water use and job creation. Validated data through over 80 expert interviews.
"Wasted food, wasted resources: Land, irrigation water, and nutrients associated with food wastage in the US" (Toth and Dou 2016)	- Quantity of FLW - Loss-adjusted food availability - Water use impacts - Land use impacts - Pesticide/fertilizer use impacts	Derived FLW quantities from the 2012 USDA ERS LAFA data series and several censuses conducted by the USDA, to model environmental impacts such as water, land and fertilizer use. These surveys included the USDA National Agricultural Statistics Service 2016, Agricultural Census Survey Program Crops Sector, USDA ERS Feed Grains, Oil Crops, USDA Census Survey Program Environmental Sector, Census of Agriculture 2013 and Farm and Ranch Irrigation Survey.
"The climate change and economic impacts of food waste in the United States" (Venkat 2011)	- Life-cycle GHG emissions from wasted food - Economic impact of wasted food	Conducted a life-cycle-based analysis of 134 food products categorized into 16 different divisions. Used food availability data and other cooking/loss modifiers to calculate the wasted food at each point in the life-cycle. GHG emissions are modeled using IPCC tier-1 guidelines. Economic impact was determined by multiplying the quantity of wasted food by its retail price. Retail prices were determined from the USDA and advertised prices from large retailers.

TABLE A6-4. FLW Baseline Inputs, for Population Levels Used in Calculations

Country	Year	Population (million)	FLW per capita (tonnes/capita/year)	Total FLW per country (million tonnes/year)
Canada	FAO 2014	36	0.36	13.1
Mexico	FAO 2014	122	0.23	28.4
United States	FAO 2014	319	0.40	126.0
Total	FAO 2014	**477**	-	**167.5**

Source: Populations from FAO 2014; FLW quantities estimated as part of report development.

TABLE A6-5. Water Used for FLW

Country	Water used for FLW per capita (m3/year)	Population (million)	Water used for FLW (billion m^3/year)	Water per tonne of FLW (million m^3/tonne)
Canada	42	36	42*36/1,000=1.5	115.8
Mexico	22	122	22*122/1,000=2.7	94.5
United States	42	319	42*319/1,000=13.4	106.3
Total	-	**477**	**17.6**	-

Source: Based on per-capita wastage of water from food loss and waste, by country region, from Kummu 2012.

TABLE A6-6. Cropland Used for FLW

Country	Cropland used for FLW, per capita (m^2/year)	Population (million)	Cropland used for FLW (million hectares/year)	Cropland per tonne of FLW (hectares/tonne)
Canada	498	36	498*36/10,000=1.8	0.14
Mexico	361	122	361*122/10,000=4.4	0.16
United States	498	319	498*319/10,000=15.9	0.13
Total	**635**	**477**	**22.1**	-

Source: Based on per-capita wastage of cropland due to food loss and waste, by country region, from Kummu 2012.

TABLE A6-7. Fertilizer Used for FLW

Country	Fertilizer per capita (tonnes/year)	Population (million)	Total fertilizer used (million tonnes/year)	Fertilizer per tonne of FLW (tonnes/tonne)
Canada	0.0093	36	0.0093*36=0.33	0.03
Mexico	0.0052	122	0.0052*122=0.63	0.02
United States	0.0093	319	0.0093*319=2.97	0.02
Total	-	**477**	**3.94**	-

Source: Based on per-capita wastage of fertilizer due to food loss and waste, by country region, from Kummu 2012.

TABLE A6-8. Economic Value of Biodiversity Loss Attributable to FLW

Country	Cropland available (million hectares/year)	Biodiversity loss (equivalent US$/hectare)	Biodiversity loss (equivalent million US$/year)	Biodiversity loss per tonne (equivalent US$/tonne)	Biodiversity loss per capita (equivalent US$/person)
Canada	1.8	14.43	1.8*14.43=26	1.98	0.72
Mexico	4.4	14.43	4.4*14.43=64	2.24	0.52
United States	15.9	14.43	15.9*14.43=229	1.82	0.72
Total	**22.1**	-	**329**	-	-

Source: Based on per-hectare dollar values of nitrogen eutrophication, phosphorus eutrophication and pesticide impacts, from FAO 2014, extrapolated for North America based on wasted cropland.

TABLE A6-9. Landfill Space Wasted for FLW

Country	Landfilled waste density (kg/m^3)	Landfilled FLW (million tonnes/year)	Landfill space wasted (million m^3/year)	Landfill space wasted per capita (m^3/year)
Canada	1,029	4.3	1,000*4.3/1,029=4.2	0.12
Mexico	1,029	8.8	1,000*4.3/1,029=8.6	0.07
United States	1,029	26.6	1,000*4.3/1,029=25.9	0.08
Total	-	**39.7**	**38.6**	-

Source: Landfilled FLW from Appendix 4.1; waste density from EPA Victoria 2016.

TABLE A6-10. Equivalent Tipping Fee Costs for FLW

Country	Average tipping fee (US$/tonne)	Landfill space wasted (million cubic meters/year)	Tipping fee wasted (US$ million/year)	Tipping fee wasted per capita (US$/year)
Canada	78	4.2	326	9
Mexico	29	8.6	249	2
United States	50	25.9	1,293	4
Total	**-**	**38.6**	**1867**	**-**

Source: Tipping fees from Green Power, Inc. 2014.

TABLE A6-11. Economic (Market) Value of FLW

Country	Reported value of FLW	Value of FLW (US$ billion/year)	Value of FLW per capita (US$/year)
Canada	C$31 billion/year	24	662
Mexico	US$36 billion/year	36	295
United States	US$218 billion/year	218	683
Total	**-**	**278**	**-**

Sources: Canada: Gooch et al. 2014; Mexico: Aguilar Gutiérrez 2016; United States: ReFED 2016.

TABLE A6-12. Calories Lost in FLW

Country	Wasted calories per capita (kcal/day)	Population	Wasted calories (trillion kcal/year)	Wasted calories per tonne of FLW (million kcal/tonne)
Canada	1,520	36	1,520*365*36/1,000,000=20	1.53
Mexico	453	122	453*365*122/1,000,000=20	0.71
United States	1,520	319	1,520*365*319/1,000,000=177	1.40
Total	**-**	**477**	**217**	**-**

Source: Based on per-capita calorie loss due to FLW, from Lipinski et al. 2013.

List of Interviews

A total of 167 interviews were conducted with stakeholders, in confidence. The objective of the interviews was to collect a diversity of opinions and depth of knowledge across the food supply chain and amongst different stakeholder types. Those interviewees cited in the research are listed by type of stakeholder, position and country of origin. Names and organizations are not listed; this is to protect sensitive and confidential information provided by interviewees.

Interview Number	Position	Country	Type of Stakeholder
C3	Professor	Canada	Academic
C7	Human Resources Manager	Canada	Agricultural Production
C8	Owner	Canada	Agricultural Production
C9	Sales and Marketing Manager	Canada	Agricultural Production
C10	Principal	Canada	Consultant
C11	Principal	Canada	Consultant
C12	Principal Consultant	Canada	Consultant
C15	Vice President, Sustainability	Canada	Distribution
C16	Director, Distribution, Equipment & Packaging	Canada	Foodservice
C17	Group Leader & Chief Operating Officer	Canada	Foodservice
C18	Owner	Canada	Foodservice
C19	Senior Director of Health, Wellness & Environmental Sustainability	Canada	Foodservice
C21	Communications and Education Coordinator	Canada	Government
C24	Director of Industry Programs	Canada	Industry Association
C26	Executive Director	Canada	Industry Association
C27	Former Executive Director	Canada	Industry Association
C28	Program Manager	Canada	Industry Association
C29	Director	Canada	Nongovernmental Organization
C30	Director	Canada	Nongovernmental Organization
C32	Director of Business Development	Canada	Nongovernmental Organization
C33	Director of Programs and Partnerships	Canada	Nongovernmental Organization
C34	Director, Communications and National Programs	Canada	Nongovernmental Organization

Interview Number	Position	Country	Type of Stakeholder
C35	Executive Director	Canada	Nongovernmental Organization
C36	Health Policy Specialist	Canada	Nongovernmental Organization
C37	Manager	Canada	Nongovernmental Organization
C39	Manager	Canada	Processing
C40	Owner	Canada	Processing
C41	Program Manager - Produce and Floral	Canada	Retail
C42	Director	Canada	Government
C43	Project Engineer	Canada	Government
C45	Program Manager	Canada	Government
C47	Program Manager	Canada	Government
C48	Founder and CEO	Canada	Nongovernmental Organization
I1	PhD Student	International	Academic
I2	VP Science and Research	International	Consultant
M1	Engineer	Mexico	Academic
M3	Researcher	Mexico	Academic
M4	Researcher	Mexico	Academic
M7	Manager	Mexico	Foodservice
M9	Owner	Mexico	Foodservice
M11	Manager	Mexico	Foodservice
M12	Coordinator	Mexico	Government
M13	Director	Mexico	Government
M15	Director of Touristic Certification	Mexico	Government
M16	Environmental Auditing Deputy Attorney	Mexico	Government
M17	Former Secretary of Environment	Mexico	Government
M19	General Director of Environmental, Urban and Touristic Promotion	Mexico	Government
M21	Researcher	Mexico	Government
M26	Executive Director of Sanitary Supervision and Surveillance	Mexico	Government
M29	Technical Director	Mexico	Government
M40	CEO	Mexico	Nongovernmental Organization

Interview Number	Position	Country	Type of Stakeholder
M43	Coordinator	Mexico	Nongovernmental Organization
M44	Director	Mexico	Nongovernmental Organization
M46	General Director	Mexico	Nongovernmental Organization
M55	Nutritionist	Mexico	Processing
M56	Administrator General	Mexico	Retail
M57	Manager	Mexico	Retail
M58	Sustainability Deputy Director	Mexico	Retail
M59	Employee, fruits and vegetables department	Mexico	Retail
M60	General Coordinator of Regulation and Economic Planning	Mexico	Government
M64	Cafeteria Manager	Mexico	Foodservice
M65	Central Manager of Customs Operations	Mexico	Government
M67	Board Members	Mexico	Retail
M68	Director	Mexico	Processing
M70	Research Coordinator	Mexico	Academic
M71	Vendor	Mexico	Retail
M72	Vendor	Mexico	Retail
M74	Owner	Mexico	Processor
M75	Frequent Customer	Mexico	Foodservice
M76	Officer	Mexico	Government
M77	Representative	Mexico	Farm
M81	Director	Mexico	Nongovernmental Organization
M82	Consultant	Mexico	Nongovernmental Organization
U1	Professor	US	Academic
U2	Master’s Student	US	Academic
U3	PhD Student	US	Academic
U4	PhD Student	US	Academic/ Nongovernmental Organization
U5	VP Marketing	US	Farm
U6	Co-founder and CEO	US	Consultant

Interview Number	Position	Country	Type of Stakeholder
U7	Editor	US	Consultant
U8	Executive Director	US	Nongovernmental Organization
U11	Project Manager	US	Consultant
U12	Would not disclose	US	Manufacturing
U13	Purchasing and Sustainability Manager	US	Foodservice
U18	Diet, Safety, and Health Economics Branch Chief	US	Government
U19	Director for Sustainable Development	US	Government
U21	Environmental Protection Specialist	US	Government
U22	Life Scientist	US	Government
U23	Program Manager	US	Government
U24	Research Leader	US	Government
U26	Senior Policy and Program Advisor	US	Government
U27	Senior Program Manager	US	Government
U28	Director of Sustainability	US	Industry Association
U29	Sustainability Manager	US	Industry Association
U30	Author	US	Nongovernmental Organization
U31	Community Outreach	US	Nongovernmental Organization
U32	Founder	US	Nongovernmental Organization
U33	President	US	Nongovernmental Organization
U34	Senior Resource Specialist	US	Nongovernmental Organization
U36	Sr. Account Manager, Manufacturing Sourcing	US	Nongovernmental Organization
U37	Corporate Social Responsibility Specialist	US	Processing
U38	VP Packaging & Sustainable Productivity	US	Processing
U39	Sustainability Manager	US	Retail
U40	Graduate Student	US	Academia
U41	Senior Associate	US	Consultant

Bibliography

Abdulla, M., R.C. Martin, M. Gooch, and E. Jovel. 2013. The importance of quantifying food waste in Canada. *Journal of Agriculture, Food Systems, and Community Development* 3(2): 137–151.

Agriculture and Agri-Food Canada. 2010. *Mexico: The Foodservice Industry*. <https://www.gov.mb.ca/agriculture/market-prices-and-statistics/trade-statistics/pubs/mexico_foodservice_en.pdf>.

Agriculture and Agri-Food Canada. 2014a. *Significance of the Food and Beverage Processing Industry in Canada*. Ottawa: Agriculture and Agri-Food Canada.

———. 2014b. Grain Handling and Transportation System – Producer Cars. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/crops-industry/initiatives-supporting-crop-producers/grain-handling-and-transportation-system-producer-cars/?id=1323989251887>. Consulted 6 March 2017.

———. 2015a. *An Overview of the Canadian Agriculture and Agri-Food System 2015.* Ottawa: Agriculture and Agri-Food Canada.

———. 2015b. *Emerging Food Innovation: Trends and Opportunities*. November. Ottawa: Agriculture and Agri-Food Canada.

———. 2016a. Significance of the Food and Beverage Processing Industry in Canada. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/significance-of-the-food-and-beverage-processing-industry-in-canada/?id=1174563085690>. Consulted 6 March 2017.

———. 2016b. Canada – At a Glance. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/agriculture-and-food-market-information-by-region/canada/?id=1410072148230>. Consulted 6 March 2017.

———. 2016c. Food Distribution in Canada. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/distribution-channels/food-distribution-in-canada/?id=1170960704448>. Consulted 6 March 2017.

———. 2016d. Canada’s Bakery and Tortilla Manufacturing Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-bakery-and-tortilla-manufacturing-industry/?id=1449839617045>. Consulted 6 March 2017.

———. 2016e. Canada’s Beer Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-beer-industry/?id=1171560813521>. Consulted 6 March 2017.

———. 2016f. Canada’s Distillery Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-distillery-industry/?id=1171995761751>. Consulted 6 March 2017.

———. 2016g. Canada’s Soft Drink, Bottled Water and Ice Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-soft-drink-bottled-water-and-ice-industry/?id=1172167862291>. Consulted 6 March 2017.

———. 2016h. Canada’s Wine Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-wine-industry/?id=1449859691976>. Consulted 6 March 2017.

———. 2016i. Canada's Dairy Product Manufacturing Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-dairy-product-manufacturing-industry/?id=1449838956652>. Consulted 6 March 2017.

———. 2016j. Canada's Seafood Product Preparation and Packaging Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-seafood-product-preparation-and-packaging-industry/?id=1449759885273>. Consulted 6 March 2017.

———. 2016k. Canada's Fruit and Vegetable Preserving and Specialty Food Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-fruit-and-vegetable-preserving-and-specialty-food-industry/?id=1375206764774>. Consulted 6 March 2017.

———. 2016l. Canada's Grain and Oilseed Milling Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-grain-and-oilseed-milling-industry/?id=1449760479129>. Consulted 6 March 2017.

———. 2016m. Canada's Meat Product Manufacturing Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-meat-product-manufacturing-industry/?id=1449838074216>. Consulted 6 March 2017.

———. 2016n. The Canadian Seasoning and Dressing Manufacturing Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/the-canadian-seasoning-and-dressing-manufacturing-industry/?id=1171632668040#s1>. Consulted 6 March 2017.

———. 2016o. Canada's Snack Food Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-snack-food-industry/?id=1172692863066>. Consulted 6 March 2017.

———. 2016p. Canada's Sugar and Confectionary Product Industry. <http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-product-sector/processed-food-and-beverages/canadas-sugar-and-confectionery-product-industry/?id=1449753264003>. Consulted 6 March 2017.

Aguilar Gutiérrez, G. 2013. Índice de Desperdicio de Alimentos en México. <http://studyres.es/doc/812010/%C3%ADndice-de-desperdicio-de-alimentos-en-m%C3%A9xico>. Consulted 30 June 2017.

———. 2016. World Bank – Mexico: Food losses and food waste in Mexico. Presentation in Mexico City, 26 July 2016. <http://www.cec.org/sites/default/files/pdf/fww/wb-presentations/6-genaro-aguilar.pdf>. Consulted 30 June 2017.

Aguilar-Virgen, Q., P. Taboada-González, and S. Ojeda-Benítez. 2013. Seasonal Analysis of the Generation and Composition of Solid Waste: Potential Use—A Case Study. *Environmental Monitoring and Assessment* 185(6): 4633–4645.

Alatriste Mendoza, Adrián. 2014. Industria Restaurantera en México. <https://es.slideshare.net/adrianalatriste/industria-restaurantera-en-mexico>. Consulted 30 June 2017.

Alimento Para Todos I.A.P. n.d. <http://www.alimentoparatodos.org.mx/index.php>. Consulted 15 November 2016.

ANAC. 2012. *Canadian Feed Stats.* <http://www.anacan.org/en/resources-links/canadian-feed-industry/canadian-feed-stats>. Consulted 15 July 2016.

Aramark. n.d. *Collecting & Tracking Food Waste Procedures*. <http://www.ct.gov/deep/lib/deep/p2/institution/tracking_&_reducing_food_waste_aramark_procedures.pdf>.

Asociación Mexicana de Diabetes. 2016. Reto por la Salud. <http://amdiabetes.org/restaurantes-salud>. Consulted 18 July 2016.

Azpiri, J. 2015. Vancouver Food Bank concerned tax incentive for corporate donations could do more harm than good. *Global News.* <http://globalnews.ca/news/2371947/vancouver-food-bank-concerned-tax-incentive-for-corporate-donations-could-do-more-harm-than-good/>.

Baldwin, G., and J. Rustemeyer. 2014. Just Eat It: A food waste story. Video. <https://www.knowledge.ca/program/just-eat-it>.

Barnes, J. 2015. Wegmans food waste efforts electrifying New York farms. *Waste Dive.* 8 June 2015. <http://www.wastedive.com/news/wegmans-food-waste-efforts-electrifying-new-york-farms/400360/>. Consulted 17 July 2016.

BCCDC (British Columbia Centre for Disease Control). 2015. *Industry Food Donation Guidelines.* <http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/EH/FPS/Food/Food%20Donation%20Guidelines%20Part%201.pdf>. Consulted 30 June 2017.

Beaman, J.A., and A.J. Johnson. 2006. *Food Distribution Channel Overview: A Guide for New Manufacturers.* Oregon State University Extension Service: 1–2.

Beck, L. 2012. What do best before dates on food really mean? *The Globe and Mail*, 19 November 2012. <http://www.theglobeandmail.com/life/health-and-fitness/ask-a-health-expert/what-do-best-before-dates-on-food-really-mean/article5381341/>.

Bergua, M., A. Perkinson, M. Oven, and T. Frankiewicz. 2016. *Global Methane Initiative Municipal Solid Waste Technical Assistance in Mexico.* Mexico City: Global Methane Initiative.

Berkowitz, S., L. Marquart, M. Reicks, E. Mykerezi, and D. Degeneffe. 2014. Providing flexible food portions in a restaurant setting: Impact on business operations, food consumption and food waste. *The Official Journal of the American Societies for Experimental Biology* 28, 390.3.

Bernache-Pérez, G., S. Sánchez-Colon, A.M. Garmendia, A. Davila-Villarreal, and M.E. Sánchez-Salazar. 2001. Solid waste characterization study in the Guadalajara Metropolitan Zone, Mexico. *Waste Management and Research* 19: 413–424.

Biocycle. 2013. Massachusetts Formally Proposes Commercial Food Waste Ban. <https://www.biocycle.net/2013/07/12/massachusetts-formally-proposes-commercial-food-waste-ban/>.

Blair, D., and J. Sobal. 2006. Luxus consumption: Wasting food resources through overeating. *Agriculture and Human Values* 23(63): 63–74.

Bloom, J. 2010. *American Wasteland: How America Throws Away Nearly Half of Its Food (and What We Can Do About It).* Philadelphia. PA: Da Capo Press, Perseus Book Group. 384 pp.

———. 2016, June. Report from Congressional Food Waste Hearing. *Biocycle*:18.

Boesveld, S. 2013. New grocery store and restaurant to sell only food that passed its best-before date, but is still perfectly fine to eat. *The National Post*, 30 September 2013. <http://nationalpost.com/news/new-grocery-store-and-restaurant-to-sell-only-food-that-passed-

its-best-before-date-but-is-still-perfectly-fine-to-eat/wcm/ac3b3a6c-e7e6-478b-a98f-99f69796ddde>.

Bradley, E., Q. Chaudhry, and L. Castle. 2011. Applications of nanomaterials in food packaging with a consideration of opportunities for developing countries. *Trends in Food Science &Technology* 22 (11):603–610.

British Columbia Ministry of Environment. 2015. *Residential Food Waste Composition Study*. <http://www2.gov.bc.ca/assets/gov/environment/waste-management/recycling/organics/resources/residential_food_waste_composition_study_ifu.pdf>. Consulted 9 August 2016.

———. 2016. Residential Food Waste Reduction Tools. <http://www2.gov.bc.ca/gov/content/environment/waste-management/recycling/organics/tools-resources/reduce-food-waste/residential-food-waste-reduction-tools>. Consulted 27 February 2017.

———. 2017. Landfills: Landfill Gas Capture. <http://www2.gov.bc.ca/gov/content/environment/waste-management/garbage/landfills>. Consulted 15 March 2017.

BSR. 2012, March. *Food Waste: Tier 1 Assessment*. <http://www.foodwastealliance.org/wp-content/uploads/2013/06/FWRA_BSR_Tier1_FINAL.pdf >

———. 2013, April. *Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Wholesalers*. <http://www.foodwastealliance.org/wp-content/uploads/2013/06/FWRA_BSR_Tier2_FINAL.pdf>.

———. 2014, November. *Analysis of U.S. Food Waste Among Food Manufacturers, Retailers, and Restaurants.* Food Waste Reduction Alliance. < http://www.foodwastealliance.org/wp-content/uploads/2014/11/FWRA_BSR_Tier3_FINAL.pdf>.

Buenrostro, O., G. Bocco, and G. Bernarche. 2001. Urban solid waste generation and disposal in Mexico: A case study. *Waste Management & Research* 19: 169–176.

Buzby, J., and J. Guthrie. 200. *Plate Waste in School Nutrition Programs.* Washington D.C.: United States Department of Agriculture. <https://naldc.nal.usda.gov/download/48204/PDF>. Consulted July 2016.

Buzby, J., H. Wells, and J. Hyman. 2014. *The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States.* Economic Research Service. Washington, DC: United States Department of Agriculture. <https://www.ers.usda.gov/webdocs/publications/eib121/43680_eib121.pdf >.

Buzby, J.C., J.T. Bentley, B. Padera, J. Campuzano, and C. Ammon. 2016. *Updated Supermarket Shrink Estimates for Fresh Foods and Their Implications for ERS Loss-Adjusted Food Availability Data.* Washington, DC: United States Department of Agriculture. <https://www.ers.usda.gov/webdocs/publications/44100/59692_eib155.pdf >.

CalRecycle. 2015. *2014 Disposal-Facility-Based Characterization of Solid Waste in California*. Sacramento: Calrecycle. <http://www.calrecycle.ca.gov/Publications/Documents/1546/20151546.pdf>. Consulted 22 November 2016.

———. n.d. Waste Characterization Studies Listing. <https://www2.calrecycle.ca.gov/WasteCharacterization/Study>. Consulted 9 August 2016.

Campus Kitchens Project. 2017. Good Samaritan Food Donation Act. The Campus Kitchens Project: Student Powered Hunger Relief. <http://www.campuskitchens.org/good-samaritan-act/#>. Consulted 15 March 2017.

Canadian Food Inspection Agency. 2014. Date Labeling on Pre-packaged Foods. <http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-infographics/date-labeling/eng/1332357469487/1332357545633>.

———. 2015. Date Markings and Storage Instructions. <http://www.inspection.gc.ca/food/labelling/food-labelling-for-industry/date-markings-and-storage-instructions/eng/1328032988308/1328034259857>. Consulted 24 February 2017.

Canirac. 2014. *Todo Sobre La Mesa: Dimensiones de la Industria Restaurantera*. Mexico City: Canirac. <http://canirac.org.mx/images/files/TODO%20SOBRE%20LA%20MESA%20ESTUDIOS%20DE%20LA%20INDUSTRIA.pdf>.

———. n.d. *Cifras del sector restaurantero.* Mexico City: Canirac. <http://canirac.org.mx/pdf/canirac-20110713-cifras-del-sector-restaurantero.pdf>.

Capulong, J. 2016. Food Donation Mobile Apps – What Has Been Done and How It Can Be Improved. Poster Presentation at IUPUI Research Day 2016, Indianapolis, Indiana, 8 April.

Cargill. 2016. Ground Beef Q&A. <http://www.cargillgroundbeef.com/learn-qa.aspx>.

CEC (Commission for Environmental Cooperation). 2017a. *Characterization and Management of Organic Waste in North America.* Montreal, QC, Canada. Prepared by Eastern Research Group, Inc., for the Secretariat of the Commission for Environmental Cooperation.

———. 2017b. North American Workshop on Food Waste Reduction and Recovery. Workshop in Toronto, Ontario, 28 February–1 March 2017.

Cech, P. 2015. Love Food Hate Waste: Household food waste reduction campaign. PowerPoint presentation, 17 June 2015. Metro Vancouver. <http://www.metrovancouver.org/events/community-breakfasts/Presentations/Peter-Cech-Love-Food-Hate-Waste-June17-Community-Breakfast.pdf>.

Champions 12.3. About. <https://champions123.org/about/>. Consulted 30 June 2017.

Chandler, A. 2016. Why Americans Lead the World in Food Waste. *The Atlantic*, July 2016. <http://www.theatlantic.com/business/archive/2016/07/american-food-waste/491513/>. Consulted October 2016.

Chrisafis, A. 2016. French law forbids food waste by supermarkets. *The Guardian,* 4 February 2016. <https://www.theguardian.com/world/2016/feb/04/french-law-forbids-food-waste-by-supermarkets>. Consulted October 2016.

City Fruit. 2014. *City Fruit 2014 Annual Report*. <https://www.cityfruit.org/sites/default/files/file-uploads/2014_city_fruit_annual_report.pdf>. Consulted 30 June 2017.

CMR. 2014. *Informe de Responsabilidad Social 2015 – Sustentar. Cuidar. Reducir*. Mexico City: CMR. <http://cmr.mx/wp-content/uploads/2016/07/Informe-RS-2014-CMR.pdf>. Consulted July 2016.

———. 2015. *La mesa está puesta para compartir – Informe de Responsabilidad Social 2015*. Mexico City: CMR. <http://fundacioncmr.org/wp-content/uploads/2014/06/Informe-de-RS-CMR-2015.pdf>. Consulted July 2016.

———. 2016. The CMR Story. <http://www.cmr.mx/en/about-cmr/vision-y-valores/>. Consulted July 2016.

Compass Group. 2012. *Environmental Policy Statement.* London: Compass Group. <http://www.compass-group.com/documents/ENVIRONMENTAL_POLICY_STATEMENT_December_2012.pdf>

Compass Group Canada. 2014. *Sustainability Highlights Report*. London: Compass Group Canada. <http://www.compass-canada.com/SiteCollectionDocuments/CRS%20Eng%20Digital.pdf>.

Compesca. 2013. Conoce el Mercado de la Nueva Viga. <http://www.comepesca.com/conoce-el-mercado-de-la-nueva-viga/>. Consulted July 2016.

Conacyt. 2016. Alfanutra- Red Nacional de Investigación, Innovación y Desarrollo Tecnológico en Alimentos Funcionales y Nutracéuticos. <http://www.alfanutra.com/>. Consulted 21 July 2016.

Coneval. 2014. Anexo estadistico de pobreza en México. <http://www.coneval.org.mx/Medicion/MP/Paginas/AE_pobreza_2014.aspx>. Consulted 15 June 2016.

Connecticut Department of Energy and Environmental Protection. 2015. Commercial Organics Recycling Law. <http://www.ct.gov/deep/cwp/view.asp?a=2718&q=552676&deepNav_GID=1645>. Consulted 17 August 2016.

———. 2016. *2015 Statewide Waste Characterization Study*. Hartford: Connecticut Department of Energy and Environmental Protection. <http://www.ct.gov/deep/lib/deep/waste_management_and_disposal/Solid_Waste_Management_Plan/CMMS_Final_2015_MSW_Characterization_Study.pdf>. Consulted August 2016.

Consumer Goods Forum. 2016. First-Ever Global Standard to Measure Food Loss and Waste Introduced by International Partnership. <http://www.theconsumergoodsforum.com/component/tags/tag/455-flw-protocol>. Consulted 27 July 2016.

Cook, K. 2014. Enterra Feed Raises $5 Million for New Langley Facility, Launches Enterra Natural Fertilizer in B.C. and Washington State. *Market Wired*. <http://www.marketwired.com/press-release/enterra-feed-raises-5-million-new-langley-facility-launches-enterra-natural-fertilizer-1893211.htm>.

Cotterman, R. 2015, October 20. A Closer Look at Food Security with Sealed Air. US Chamber of Commerce Foundation. <https://www.uschamberfoundation.org/blog/post/closer-look-food-security-sealed-air/43959>.

Crane, M. 2017. Worries about food waste appear to vanish when diners know scraps go to compost. *The Ohio State University News*, 3 January 2017. <https://news.osu.edu/news/2017/01/03/food-waste-compost/>. Consulted 2 March 2017.

CSC Brands, L.P. 2013. 'Just Peachy' Salsa Provides Funds To Help Food-Insecure Families. Campbell's Soup Company. <https://www.campbellsoupcompany.com/newsroom/news/2013/11/21/just-peachy-salsa/>. Consulted 15 November 2016.

Dalhousie University. n.d. Dining: From On-Campus Dining Halls to Nearby Restaurants. <https://www.dal.ca/dept/summer-accommodations/halifax-accommodations/dining-parking-and-athletics/dining.html.> Consulted 30 June 2017.

Davis, A. 2008. Eliminating College Dining Hall Trays Cuts Water, Food Waste. *ABC News*, 25 October 2008. <http://abcnews.go.com/OnCampus/story?id=6087767&page=1>.

Desmet B. 2013. About Stolz. <http://www.desmetballestra.com/index.php/equipment/animal-feed-equipment/about-stolz>.

Discovery Organics. 2016. Help out farmers and BE A REBEL!. <http://www.discoveryorganics.ca/market-report-mar-18th-2016/>.

DOF (Diario Oficial de la Federación). 2007. Artículo 199-Bis de la Ley General de Salud. <http://www.diputados.gob.mx/LeyesBiblio/pdf/142_270117.pdf>. Consulted May 2017.

———. 2010. NOM-051-SCFI/SSA1-2010, Especificaciones generales de etiquetado para alimentos y bebidas no alcohólicas preenvasados—Información comercial y sanitaria. <http://www.dof.gob.mx/nota_detalle.php?codigo=5137518&fecha=05/04/2010>. Consulted May 2017.

———. 2013. DECRETO por el que se establece el Sistema Nacional para la Cruzada contra el Hambre. *SEGOB.* <http://dof.gob.mx/nota_detalle.php?codigo=5285363&fecha=22/01/2013>. Consulted 14 June 2016.

———. 2014. Ley general de organizaciones y actividades auxiliares del crédito. <http://www.diputados.gob.mx/LeyesBiblio/pdf/139.pdf>. Consulted November 2016.

———. 2016. Ley del impuesto sobre la renta. <http://www.diputados.gob.mx/LeyesBiblio/pdf/LISR_301116.pdf>. Consulted May 2017.

Domenic, V., J.A. Grisso, K.L. Whiteside, and R. Fischman. 2015. From commodity surplus to food justice: Food banks and local agriculture in the United States. *Agriculture and Human Values* 32: 419–430.

Don Asado. N.d. Don Asado La pizzería. <http://www.donasado.com.mx/polanco/>. Consulted 22 July 2016.

Donnelly, Melissa. 2015. Campbell’s Just Peachy Salsa: Best Practice Case Study. *Food Waste Reduction Alliance.* <http://www.foodwastealliance.org/wp-content/uploads/2015/11/20392_ToolkitCaseStudy_Campbells_05.pdf>. Consulted 30 June 2017.

Draper/Lennon, Inc. and Atlantic Geoscience Corp. 2001. *Identifying, Quantifying, and Mapping Food Residuals from Connecticut Businesses and Institutions*. <http://www.ct.gov/deep/lib/deep/compost/ssomfile/ssomreport.pdf>.

DuPont. 2015. DuPont Advanced Materials in New Recloseable, Resealable Package Can Reduce Food Waste. <http://www.dupont.com/industries/packaging-and-printing/media/press-releases/bemis-reclosable-resealabe-cheese-packaging.html>.

Duran Moreno, A., M. Garcés Rodríguez, A. Rocío Velasco, J.C. Marin Enríquez, R. Gutiérrez Lara, A. Moreno Gutiérrez, and N.A. Delgadillo Hernández. 2013. Mexico City's Municipal Solid Waste Characteristics and Composition Analysis. *Rev. Int. Contam. Ambie* 29(1): 39–46.

EC (European Commission). 2014. *FUSIONS Definitional framework for food waste*. <www.eu-fusions.org/phocadownload/Publications/FUSIONS Definitional Framework for Food Waste 2014.pdf>. Consulted July 2016.

———. 2016. *Food Waste Quantification Manual to Monitor Food Waste Amounts.* Paris: European Commission (FP7), Coordination and Support Action - CSA.

———. N.d. New four year EU project on food waste: REFRESH (Resource Efficient Food and Drink for the Entire Supply Chain). <http://www.eu-fusions.org/index.php/about-fusions/news-

archives/261-new-four-year-eu-project-on-food-waste-refresh-resource-efficient-food-and-drink-for-the-entire-supply-chain>. Consulted October 2016.

ECCC (Environment and Climate Change Canada). 2012. Landfills. <http://www.climatechange.gc.ca/default.asp?lang=En&n=60CB860C-1>. Consulted 11 August 2016.

———. 2013. Greenhouse Gases (GHG) Calculator for Waste Management. <https://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=D6A8B05A-1>. Consulted 13 August 2016.

———. 2016. *National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada*. <https://ec.gc.ca/ges-ghg/default.asp?lang=En&n=662F9C56-1>. Consulted 11 August 2016.

Edible Garden Project. 2010. North Shore Fruit Tree Project. <http://ediblegardenproject.com/2010/07/13/north-shore-fruit-tree-project/>.

El-Fadel, M., A.N. Findikakis, and J.O. Leckie. 1997. Environmental Impacts of Solid Waste Landfilling. *Journal of Environmental Management* 50: 1–25. <https://www.researchgate.net/profile/Mutasem_El-Fadel/publication/223197655_Environmental_Impacts_of_Solid_Waste_Landfilling/links/56a9aff308ae2df821653b95.pdf>.

Encyclopedia Britannica. 2016. Nongovernmental organization (NGO). Consulted October 2016. <https://www.britannica.com/topic/nongovernmental-organization>.

Enterra Feed Corporation. 2016. Our History. <http://www.enterrafeed.com/about/#history>. Consulted 16 November 2016.

Environment Protection Authority Victoria (EPA Victoria). 2016. Waste Materials – Density Data. <http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/~/media/Files/bus/EREP/docs/wastematerials-densities-data.pdf>.

European Food Information Council. 2016. Food Processing. <http://www.eufic.org/page/en/food-technology/food-processing/>. Consulted November 2016.

FAO (Food and Agriculture Organization of the United Nations). 2011. “Energy-smart” agriculture needed to escape fossil fuel trap. <http://www.fao.org/news/story/en/item/95161/icode/>. Consulted 24 February 2017.

———. 2013. *Food wastage footprint – Impacts on natural resources. Summary report*. <http://www.fao.org/docrep/018/i3347e/i3347e.pdf>.

———. 2014. *Food wastage footprint – Full-cost accounting*. < http://www.fao.org/3/a-i3991e.pdf>.

———. 2016a. Second Regional Dialogue on Prevention and Reduction of food losses and waste in Latin America and the Caribbean.. <http://www.fao.org/save-food/news-and-multimedia/events/detail-events/en/c/445638/>.

———. 2016b. Technical Platform on the Measurement and Reduction of Food Loss and Waste. <http://www.fao.org/platform-food-loss-waste/en/>. Consulted August 2016.

———. 2017. Food Balance Sheets. FAOSTAT. <http://www.fao.org/faostat/en/#data/QC> Consulted April 2017.

Feeding America. 2014. *Hunger in America 2014 National Report.* <http://help.feedingamerica.org/HungerInAmerica/hunger-in-america-2014-full-report.pdf>.

———. 2015. *Comments Submitted by Feeding America to the Senate Finance Committee.* Washington: Senate Finance.

———. 2016. 2016 Changes to Food Donation Tax Incentives. <http://1rjlir1zshqh1p90ct3eal67.wpengine.netdna-cdn.com/wp-content/uploads/mp/files/tool_and_resources/files/feeding-america-2016-food-donation-tax-law-changes.pdf>. Consulted July 2016.

———. 2017a. Connecting Health and Nutrition: Food Bank Makes Nourishing Foods More Accessible with Mobile Kitchen Cart. <http://www.feedingamerica.org/hunger-in-america/news-and-updates/hunger-blog/connecting-health-and-nutrition.html>.

———. 2017b. Protecting Our Food Partners. <http://www.feedingamerica.org/ways-to-give/give-food/become-a-product-partner/protecting-our-food-partners.html?referrer=https://www.google.com/>. Consulted 15 March 2017.

Ferguson, James D. 2016. Food Waste as Animal Feed. In *Food Waste Across the Supply Chain: A US Perspective on a Global Problem*, 235–261. University of Pennsylvania.

Fisheries and Oceans Canada. 2012. *Aquaculture in Canada 2012: A Report on Aquaculture Sustainability*. <http://www.dfo-mpo.gc.ca/aquaculture/lib-bib/asri-irda/asri-irda-2012-eng.htm#_4.5>.

FOCIR-Sagarpa. 2015. FOCIR. <http://www.focir.gob.mx/template1.aspx?nombre=Sistema%20Nacional%20de%20Agroparques>. Consulted 19 July 2016.

Foderaro, L.W. 2009. Without Cafeteria Trays, Colleges Find Savings. *The New York Times*, 29 April 2009. <http://www.nytimes.com/2009/04/29/nyregion/29tray.html?_r=0>.

Fonterra Co-operative Group. n.d. What is Foodservice? <https://www.anchorfoodprofessionals.com/global/en/about-us/what-is-food-service.html>. Consulted October 2016.

Food and Consumer Products of Canada. 2015. *FCPC Submission in Response to BC Climate Leadership Plan Discussion Paper. Province of British Columbia.* North York: Food and Consumer Products of Canada. <https://engage.gov.bc.ca/climateleadership/files/2015/12/022_-Food-and-Consumer-Products-of-Canada.pdf>. Consulted 4 August 2016.

Food Banks Canada. 2013. Guideline for Distributing Food Past the Best Before Date. British Columbia Centre for Disease Control. <http://www.bccdc.ca/resource-gallery/Documents/Educational%20Materials/EH/FPS/Food/FoodBanksCanadaGuidelinesforFoodShelfLife2013.pdf>.

———. 2014. *2014 Donor Impact Report: Your support, your impact, your Food Banks Canada.* Mississauga: Food Banks Canada.

———. 2016a. Hunger Count 2016. <https://www.foodbankscanada.ca/getmedia/6173994f-8a25-40d9-acdf-660a28e40f37/HungerCount_2016_final_singlepage.pdf>.

———. 2016b. Retail Food Program. <https://www.foodbankscanada.ca/About-Us/Programs/Retail-Food-Program.aspx>.

———. 2017. Links and Resources: Good Samaritan Acts. <https://www.foodbankscanada.ca/Hunger-in-Canada/Links-and-resources.aspx>. Consulted 15 March 2017.

Food Banks of Quebec. 2015. Food donations. <http://www.banquesalimentaires.org/en/get-involved/food-donations/>. Consulted 15 March 2017.

Food Cowboy. 2015. Food Waste Innovation Fund. <http://www.foodcowboy.com/food_waste_innovation_fund>.

Food Donation Connection. 2015. United States legal liability issues. Food Donation Connection: Let Nothing Be Wasted. <http://www.foodtodonate.com/Fdcmain/LegalLiabilities.aspx>. Consulted 15 March 2017.

Food Retail World. 2015. Definitions. <http://www.foodretailworld.com/Definitions.htm>.

Food Safety Magazine. 2009. Food Service Distribution: Maintaining the Cold Chain. *Food Safety Magazine.* September 2009. <http://www.foodsafetymagazine.com/magazine-archive1/augustseptember-2009/foodservice-distribution-maintaining-the-cold-chain/>. Consulted 22 June 2016.

Food System Primer. n.d. Food Processing. Johns Hopkins Bloomberg School of Public Health. Centre for a Livable Future. <http://www.foodsystemprimer.org/food-processing/>.

Food Waste Reduction Alliance. 2013. Food Waste Reduction Alliance Logo. <http://www.foodwastealliance.org/>.

———. 2015. *Best Practices & Emerging Solutions Guide.* <http://www.foodwastealliance.org/wp-content/uploads/2013/05/2015FWRAToolkit_Web_FINAL.pdf>. Consulted July 2016.

FoodShift. 2017. Good Samaritan Act: Protecting food donors from liability since 1996. <http://foodshift.net/good-samaritan-food-act/>. Consulted 15 March 2017.

Forgotten Harvest. 2016. About Us. <http://www.forgottenharvest.org/page.aspx?p=6>. Consulted July 2016.

Fruitcycle. 2016. Our Story. <http://www.thefruitcycle.com/#our-story>. Consulted July 2016.

Fundación UNAM. 2013. *La ciudad que no miramos—Hoy Central de Abastos (CEDA).* <http://www.fundacionunam.org.mx/humanidades/la-ciudad-que-no-miramos-hoy-central-de-abasto-ceda/>. Consulted 19 June 2016.

Further With Food. 2017. There are millions of tons of food loss and waste in the United States. <https://furtherwithfood.org/wp-content/uploads/2017/01/Food-Loss-Waste-Data-Comparisons.pdf>.

Gaceta Oficial de la Ciudad de México. 2017. (Official Gazette of the City of Mexico.) Órgano de Difusión del Gobierno de la Ciudad de México. <http://www.ordenjuridico.gob.mx/Documentos/Estatal/Ciudad%20de%20Mexico/wo119835.pdf>.

García-Lara, S., and D. Bergvinson. 2007. Integral program to reduce post-harvest losses in maize. *Agricultura Técnica en México*: 182–183. <http://www.scielo.org.mx/pdf/agritm/v33n2/v33n2a8.pdf>. Consulted December 2017.

Garnett, T. 2008. Cooking up a storm: Food, greenhouse gas emissions and our changing climate. *Food Climate Research Network.* <http://www.fcrn.org.uk/sites/default/files/CuaS_web.pdf>. Consulted 6 August 2016.

Gase, L., L. Dunning, T. Kuo, P. Simon, and J.E. Fielding. 2014. Restaurant Owner's Perspective on a Voluntary Program to Recognize Restaurants for Offering Reduced Sized Portions, Los Angeles County, 2012. *Preventing Chronic Disease* 11: E44.

Geiling, N. 2015. The U.S. Government Wants to Cut Food Waste in Half. *ThinkProgress*, 117 September 2015. <http://thinkprogress.org/climate/2015/09/17/3702620/usda-epa-food-waste-goals/>. Consulted June 2016.

Gill, V. July 2013. *Fast and Fresh: A Recipe for Canada's Food Supply Chains.* Ottawa: Conference Board of Canada.

Giroux, L. 2014. State of Waste Management in Canada. <http://www.ccme.ca/files/Resources/waste/wst_mgmt/State_Waste_Mgmt_in_Canada%20April%202015%20revised.pdf>. Consulted 9 August 2016.

Godoy, M. 2016. Wal-Mart, America's Largest Grocer, Is Now Selling Ugly Fruit and Vegetables. *NPR The Salt*. Consulted October 2016. <http://www.npr.org/sections/thesalt/2016/07/20/486664266/walmart-world-s-largest-grocer-is-now-selling-ugly-fruit-and-veg>.

Gold Strike Casino Resort. <https://www.goldstrike.com>. Consulted 30 June 2017.

Gómez, G., M. Meneses, L. Ballinas, and F. Castells. 2009. Seasonal characterization of municipal solid waste (MSW) in the city of Chihuahua, Mexico. *Waste Management* 29: 2018–2024.

Gómez, M., and R. Schventesius. 2006. Supermercados y pequeños productores hortofrutícolas en México. *Comercio Exterior* 56. <http://revistas.bancomext.gob.mx/rce/magazines/89/3/Gomez-Schventesius.pdf>. Consulted 30 June 2017.

Gooch, M., A. Felfel, and N. Marenick. 2010. Food Waste in Canada: Opportunities to increase the competitiveness of Canada's agri-food sector, while simultaneously improving the environment. November. <http://vcm-international.com/wp-content/uploads/2013/04/Food-Waste-in-Canada-112410.pdf>. Consulted July 2016.

Gooch, M., A. Felfel, and C. Glasbey. 2014. *$27 Billion" Revisited: The Cost of Canada's Annual Food Waste.* VCM International, Inc.

Government of British Columbia. 2016. B.C. Farmers' Food Donation Tax Credit. <http://www2.gov.bc.ca/gov/content/taxes/income-taxes/corporate/credits/farmers-food-donation>. Consulted 14 March 2017.

Government of Canada. 2011. *Fresh Fruit and Vegetable Regulations*. <http://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._285/>. Consulted July 2016.

———. 2012. Harper Government Invests in Safe Food Transportation. <https://www.canada.ca/en/news/archive/2012/10/harper-government-invests-safe-food-transportation.html?=undefined&wbdisable=true>. Consulted 6 March 2017.

———. 2016a. Rendering and Meat Processing from Carcasses (311614). <http://www.ic.gc.ca/app/ccc/sld/cmpny.do?lang=eng&profileId=1921&naics=311614>.

———. 2016b. Key Small Business Statistics – June 2016. Innovation, Science and Economic Development Canada. <https://www.ic.gc.ca/eic/site/061.nsf/eng/03021.html>. Consulted 24 February 2017.

———. 2016c. How Nutrition North Canada Works. <http://www.nutritionnorthcanada.gc.ca/eng/1415538638170/1415538670874>. Consulted 6 March 2017.

———. 2016d. Leaders' Statement on North American Climate, Clean Energy, and Environment Partnership. <http://pm.gc.ca/eng/news/2016/06/29/leaders-statement-north-american-climate-clean-energy-and-environment-partnership>. Consulted 14 March 2017.

Government of Nova Scotia. 2016. Tax Credit Supports Farmer Donations to Food Banks. <http://novascotia.ca/news/release/?id=20160519005>. Consulted 27 July 2016.

Government of Ontario. 1994. O. Reg. 102/94: Waste Audits and Waste Reduction Work Plans under Environmental Protection Act, R.S.O. 1990, c. E. 19. <https://www.ontario.ca/laws/regulation/940102>.

———. 2016a. Bill 151, Waste-Free Ontario Act, 2016. <http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&BillID=3598>.

———. 2016b. Strategy for a Waste-Free Ontario: Building a Circular Economy. <http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2016/012-9356.pdf>.

Government of Quebec. 2016. P-29, r. 3 – Regulation respecting fresh fruits and vegetables. <http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/P-29,%20r.%203/>.

Green Power Inc. 2014. Landfill Tipping Fees in USA. <http://www.cleanenergyprojects.com/Landfill-Tipping-Fees-in-USA-2013.html>. Consulted 20 February 2017.

Greenpeace Mexico. 2016. *¿Cómo leer etiquetas?*. <http://www.greenpeace.org/mexico/es/Actua/Ecotips/Como-leer-etiquetas-/>.

Grocery Manufacturers Association. 2017. Grocery Industry Launches New Initiative to Reduce Consumer Confusion on Product Date Labels. <http://www.gmaonline.org/news-events/newsroom/grocery-industry-launches-new-initiative-to-reduce-consumer-confusion-on-pr/>. Consulted 7 March 2017.

Grolleaud, M. 2001. *Post-harvest losses: Discovering the full story*. Italy: Food and Agriculture Organization of the United Nations. <http://www.fao.org/docrep/004/ac301e/AC301e00.htm>.

Guadarrama-Sistos, R. 2013. Sistema Nacional de Abasto Alimentario. <http://es.slideshare.net/isidropedraza/sistema-nacional-de-abasto-alimentario>. Consulted 31 May 2016.

Gunders, D. 2012. *Wasted: How America is Losing up to 40% of its Food From Farm to Fork.* NRDC Issue Paper. NRDC.

Gustavsson, J., C. Cederberg, U. Sonesson, R. van Otterdijk, and A. Meybeck. 2011. *Global Food Losses and Food Waste: Extent, Causes and Prevention.* Rome: Food and Agriculture Organization of the United Nations.

Gustavsson, J., C. Cederberg, U. Sonesson, and A. Emanuelsson. 2013. *The methodology of the FAO study: "Global Food Losses and Food Waste – extent, causes and prevention"– FAO, 2011.* Stockholm: SIK – The Swedish Institute for Food and Biotechnology.

Gutiérrez, G. 2017. Mexico Food Waste. Mexican Restaurant Association. <http://www.cec.org/sites/default/files/pdf/fww/presentations/1mar-_pm_foodwaste_gomez_final.pdf>. Consulted 30 June 2017.

Hall, K., J. Guo, M.l Dore, and C. Carson. 2009. The Progressive Increase of Food Waste in America and Its Environmental Impact. *Plos One* 11: e790.

Hanner, K. 2017. Together We Can Solve Hunger: Food Rescue to Help Feed People – Feeding America. Presentation at the North American Workshop on Food Waste Reduction and Recovery, Toronto, Ontario, 28 February–2 March 2017.

Hanson, C., and P.Mitchell. 2017. *The Business Case For Reducing Food Loss and Waste*. Champions 12.3. <https://champs123blog.files.wordpress.com/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf >.

Harvard Food Law and Policy Clinic. 2017. *Don't Waste, Donate: Enhancing Food Donations through Federal Policy*. <http://www.chlpi.org/wp-content/uploads/2013/12/Dont-Waste-Donate_-March-2017.pdf>.

Health Canada. 2013. Best Before and Expiration Dates on Foods – What do they mean? *Healthy Canadians*, 28 March 2013. <http://www.healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2012/13660a-eng.php>.

Heller, M.C., and G.A. Keoleian. 2003. Assessing the sustainability of the US food system: a life cycle perspective. *Agricultural Systems* 76: 1007–1041. <https://www.researchgate.net/profile/Martin_Heller4/publication/222558388_Assessing_the_sustainability_of_the_US_food_system_A_life_cycle_perspective/links/09e41511b158d5f5c0000000.pdf>.

Hernández Guzmán, J.A., and A. Carballó Carballó. *Almacenamiento y conservación de granos y semillas.* SAGARPA. <http://www.sagarpa.gob.mx/desarrollorural/documents/fichasaapt/almacenamiento%20de%20semillas.pdf>. Consulted 16 November 2016.

Herrera, C. 2012. *Guía de Orientación de la Norma Oficial Mexicana*. <https://prezi.com/dldew7qwbaua/guia-de-orientacion-de-la-norma-oficial-mexicana-nom-050-scfi-1994/>.

Hoekstra, A.Y, A.K. Chapagain, M.M. Aldaya, and M.M. Mekonnen. 2011. *The Water Footprint Assessment Manual: Setting the Global Standard.* London: Earthscan.

Hospitales Angeles. n.d. Salud y Vida. <https://www.hospitalesangeles.com/saludyvida/articulo.php?id=5071>. Consulted April 2017.

Hoy No Circula. 2016. ¿Qué es el programa Hoy No Circula? <http://www.hoy-no-circula.com.mx/>. Consulted November 2016.

Hughes, A.J. 2015. Award-Winning Film Reveals Incredible Amount of Transport Food Waste on U.S.-Mexico Border. <http://seedstock.com/2015/06/24/award-winning-film-reveals-incredible-amount-of-transport-food-waste-on-u-s-mexico-border/>. Consulted 30 June 2017.

ICF Consulting. 2005. *Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update.* Ottawa: Government of Canada.

IFPRI. 2016. *2016 Global Food Policy Report.* Washington, DC: International Food Policy Research Institute.

Inbound Logistics Latam. 2016. Inbound Logistics Latam. 16 June. <http://www.il-latam.com/blog/business-context/mexico-a-la-vanguardia-en-la-cadena-de-frio-para-alimentos-refrigerados-y-congelados>. Consulted 20 June 2016.

INECC. 2011. National Greenhouse Gas Emissions Inventory. <http://www2.inecc.gob.mx/publicaciones/libros/654/nationalgreenhouse.pdf>. Consulted 13 August 2016.

———. 2016. Inventario Nacional de Emisiones de Gases y Compuestos de Efecto Invernadero. November 10. <http://www.gob.mx/inecc/acciones-y-programas/inventario-nacional-de-emisiones-de-gases-y-compuestos-de-efecto-invernadero>.

INEGI (Instituto Nacional de Estadística y Geografía). 2014a. Censos Económicos 2014: Resultados definitivos. <http://www.beta.inegi.org.mx/app/saic/default.aspx>. Consulted 30 June 2017.

———. 2014b. *Directorio Estadístico de Unidades Económicas.* <http://www.beta.inegi.org.mx/app/mapa/denue/default.aspx>. Consulted 12 July 2016.

Investopedia. 2010. 5 Products That Cost Way More In Canada. <http://www.investopedia.com/financial-edge/1110/5-products-that-cost-way-more-in-canada.aspx>. Consulted 10 November 2016.

Jackson, D. 2005. *8th Annual LMOP Conference Proceedings*. US EPA. <https://www3.epa.gov/lmop/documents/pdfs/conf/8th/presentation-jackson.pdf>. Consulted 8 November 2016.

Jean-Baptiste, N. 2013. People centered approach towards food waste management in the urban environment of Mexico. <https://e-pub.uni-weimar.de/opus4/frontdoor/index/index/docId/2063>. Consulted 15 August 2016.

Journal of Agriculture, Food Systems and Community Development. 2014. <https://www.foodsystemsjournal.org/index.php/fsj/issue/view/11>. Consulted 30 June 2017.

Kagan, R. 2013. Food Waste and Canada's Food Manufacturing Sector. *Cut Waste, Grow Profit, 2nd Annual Food Waste Forum.* Value Chain Management Centre.

Kalinowicz, M. 2017. Quebec grovery stores in province-wide program to send unused produce to food banks. *Global News*, 13 March 2017. <http://globalnews.ca/news/3302074/quebec-grocery-stores-first-in-canada-to-send-unused-produce-to-food-banks/?utm_source=GlobalEdmonton&utm_medium=Facebook>. Consulted 13 March 2017.

Kantor, L., K Lipton, A. Manchester, and V. Oliveria. 1997. *Estimating and Addressing America's Food Losses.* Food Review 12. USDA.

Kazda, K. 2016. How to Feed 350 Food Waste Experts. *Sustainable America Blog*. 18 July. <http://www.sustainableamerica.org/blog/how-to-feed-350-food-waste-experts/?utm_content=bufferea57c&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer>.

Keener, L. 2003. Transportation: The Squeaky Wheel of the Food Safety System. *Food Safety Magazine*, October/November 2003. <http://www.foodsafetymagazine.com/magazine-archive1/octobernovember-2003/transportation-the-squeaky-wheel-of-the-food-safety-system/>.

Kelleher, M., and J. Robins. 2013. What Is Waste Food? *Biocycle*: 36.

Kelly, J.. 2014. Vermont's Universal Recycling Law: Waste reduction through a Food Recovery Hierarchy. UVM Food Feed – Sustainable Food Systems & The University of Vermont. <https://learn.uvm.edu/foodsystemsblog/2014/08/07/vermonts-universal-recycling-law-waste-reduction-through-a-food-recovery-hierarchy/>. Consulted July 2016.

Killinger, J. 2011. Smart Plastic Packaging Can Reduce the Environmental and Economic Impacts of Food Waste. Press release. American Chemistry Council, 16 August 2011. <https://www.americanchemistry.com/Media/PressReleasesTranscripts/ACC-news-releases/Smart-Plastic-Packaging-Can-Reduce-the-Environmental-and-Economic-Impacts-of-Food-Waste.html>.

Kim, K., and S. Morawski. 2012. Quantifying the Impact of Going Trayless in a University Dining Hall. *Journal of Hunger & Environmental Nutrition* 7(4): 482–486.

Knapp, S. 2009. Dartmouth Dining Services re-energizes sustainability efforts. *Dartmouth News*. <http://www.dartmouth.edu/~news/releases/2009/06/03.html#top>. Consulted October 2016.

Kummu, M., H. de Moel, M. Porkka, S. Siebert, O. Varis, and P.J. Ward. 2012. Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of the Total Environment* 438: 477–489.

L.A. Kitchen. 2016. L.A. Kitchen. <http://www.lakitchen.org/>.

Lamilla, J. n.d. Transitioning to Person Centered Dining. <http://www.arhealthcare.com/sites/default/files/content/u24/Restaurant%20Style%20Dining.pdf>.

LeanPath. n.d.a. Gold Strike Resort & Casino: Cutting Down Food Wasted and Food Cost. <http://www.leanpath.com/docs/case-studies/MGMGoldStrike.pdf>. Consulted July 2016.

———. n.d.b. Food Waste Prevention Spotlight. <http://www.leanpath.com/wp-content/themes/weaver-ii-pro/docs/LeanPath_Case_Study_UMass.PDF>. Consulted 15 June 2016.

Leib, E.B., C. Rice, O. Balkus, J. Mahoney, A. Anello, J. Brown, R. Cheng, E. Dunyak, D. Edelstein, C. Golden, C. Hensley, M. Jerrett, M. Malavey, S. Montgomery, K. Sandson, M. Shkuratov, S. Xie, and C. Zhong. 2016. *Keeping Food Out of the Landfill: Policy Ideas for States and Localities*. Harvard Food Law and Policy Clinic. <http://www.chlpi.org/wp-content/uploads/2013/12/Food-Waste-Toolkit_Oct-2016_smaller.pdf>. Consulted 11 November 2016.

Levin, A. 2012. Green Tip: Trayless Dining. <http://fesmag.com/features/foodservice-issues/10237-trayless-dining>. Consulted July 2016.

Lingle, R. 2016. *Experts identify packaging solutions to address food waste.*. <http://www.packagingdigest.com/optimization/experts-identify-packaging-solutions4foodwaste1604>.

Lipinski, B., C. Hanson, J. Lomax, L. Kitinoja, R. Waite, and T. Searchinger. 2013. *Reducing Food Loss and Waste.* Washington, DC: World Resources Institute.

Loblaw. 2015. *Loblaw Corporate Social Responsibility Report*. <http://www.loblaw-reports.ca/responsibility/2015/index.html#17>.

Luna, T. 2015. Nonprofit grocery store set to open in Dorchester. *Boston Globe*, 22 May 2015. <https://www.bostonglobe.com/business/2015/05/21/nonprofit-daily-table-grocery-store-set-open-dorchester/CBzBHC1RsEOVCSgOFa0p9O/story.html>.

Lunau, K. 2016. Quebec Finally Got Rid of Its Bizarre Ban on Selling Ugly Fruit. *Motherboard Vice*, 1 August 2016. <https://motherboard.vice.com/en_us/article/ugly-fruit-quebec-food-waste-ban-loblaws-walmart>. Consulted October 2016.

MacRae, R., A. Siu, M. Kohn, M. Matsubuchi-Shaw, D. McCallum, T. Hernandez Cervantes, and D. Perreault. 2016. Making better use of what we have: Strategies to minimize food waste and resource efficiency in Canada. *Canadian Food Studies* 3(2): 145–325.

Maines Paper and Food Service, Inc. n.d. Refrigerated Trucks. <https://www.maines.net/produce-express/technology/refrigerated-trucks>. Consulted 30 June 2017.

Manuell, R. 2017. US sell-by-date labelling is about to change… in a big way. *New Food Magazine*, 17 February 2017. <http://www.newfoodmagazine.com/33919/blogs/sell-by-date-revolution-labelling/>. Consulted 2 March 2017.

Marra, F. 2013. *Fighting Food Loss and Food Waste in Japan.* Leiden: Leiden University.

Marshman, J. 2015. *Gleaning in the 21st Century: Urban Food Recovery and Community Food Security in Ontario*. Master's Thesis. University of Waterloo.

Massachusetts Department of Environmental Protection. n.d. *Commercial Food Waste Disposal Ban.* <http://www.mass.gov/eea/agencies/massdep/recycle/reduce/food-waste-ban.html>. Consulted 25 May 2016.

Massow, M. von. 2013. Relationship between Menu Items, Product Engineering and Profit. Cut Waste, Grow Profit – Second Annual Food Waste Forum. Value Chain Management Centre.

McGillvray, K. 2016. Animal rendering plant causing horrible smell, RDP resident says. *CBC News*, 7 July 2017. <http://www.cbc.ca/news/canada/montreal/sanimax-smell-rdp-1.3668726>. Consulted July 2016.

McHenry, K. 2013. *Hungry for Peace: How you can help end poverty and war with Food Not Bombs.* Tucson: Sharp Press.

McLeod, W. 2015. *BC Tree Fruits Joins Forces with BC's Number One Craft Cider.* <https://www.kelownanow.com/watercooler/news/news/Provincial/15/09/23/BC_Tree_Fruits_Joins_Forces_with_BC_s_Number_One_Craft_Cider/>. Consulted July 2016.

MD Consultaría. 2015. *Desarrollo de la metodología para la estimación de pérdida y desperdicio de alimentos en México*. December 2015. <http://www.gob.mx/cms/uploads/attachment/file/109711/Perdida-y-desperdicio-de-alimentos-marzo16-_j_-ilovepdf-compressed-1-58.pdf>, <http://www.gob.mx/cms/uploads/attachment/file/109712/Perdida-y-desperdicio-de-alimentos-marzo16-_j_-ilovepdf-compressed-59-115.pdf>.

Meadows, D.H. 2008. *Thinking in Systems: A Primer.* White River Junction: Chelsea Green Publishing Company.

Medical Dictionary for the Health Professions and Nursing. 2012. Food rendering. < http://medical-dictionary.thefreedictionary.com/food+rendering>.

Medina, S. 2009. Las Cadenas de Frío y el Autotransporte Refrigerado. Comercio Exterior: 23.

Meinhardt, M. 2015. The Misfits: A Food Revolution in the Making. 2015 Conference on Canadian Stewardship and RCA Waste Reduction – Conference "Under the Big Top."

Melvin, J. 2008. U.S. food portions: Monuments of decadence? *Reuters*. <http://www.reuters.com/article/us-food-usa-portions-idUSN2639845320080729>. Consulted October 2016.

Mena, C., B. Adenso-Diaz, and O. Yurt. 2011. The causes of food waste in the supplier–retailer interface: Evidences from the UK and Spain. Resources, Conservation and Recycling 55(6):648–658.

Merriam-Webster. 2016. Definition of Business. <http://www.merriam-webster.com/dictionary/business>. Consulted October 2016.

Messenger, B. 2015. WRAP Report: Cutting Food Waste Key to Security of Supply. <https://waste-management-world.com/a/wrap-report-cutting-food-waste-key-to-security-of-supply>. Consulted November 2016.

Metro Vancouver. 2015a. About Food Scraps Recycling. <http://www.metrovancouver.org/services/solid-waste/food-scraps-recycling/background-implementation/Pages/default.aspx>. Consulted 7 August 2016.

———. 2015b. *Metro Vancouver 2014 ICI Waste Characterization Program.* Burnaby: Metro Vancouver. <http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/FinalReport-2014ICIWasteCharacterizationProgram3-Jun-15.pdf>. Consulted 9 August 2016.

———. 2016. *2015 Waste Composition Monitoring Program*. Burnaby: Metro Vancouver. <http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/2015_Waste_Composition_Report.pdf>. Consulted 9 August 2016.

Midgley, J.L. 2014. The logics of surplus food redistribution. *Journal of Environmental Planning and Management* 57(12): 1872–1892.

Mior, C.. 2009. Strategies to reduce waste in patient foodservices. Aramark.

Moisson Montréal. 2015a. *Annual Report 2014/2015*. Montreal: Moisson Montréal.

———. 2015b. Moisson Montréal's Food Recovery Program in Supermarkets. <http://www.moissonmontreal.org/en/frps-results-october-2015/>.

Moore, D. 2016. Courtauld Commitment 2025 to Transform UK Food And Drink. Chartered Institution of Wastes Management (CIWM). <http://www.ciwm-journal.co.uk/courtauld-commitment-2025-transform-uk-food-drink/>.

Morales, C. 2016. Instituto Mexicano del Transporte. Evolución de la flota de autotransporte refrigerado en México. <http://imt.mx/archivos/Publicaciones/PublicacionTecnica/pt461.pdf>. Consulted 11 July 2016.

Mott, R. 2015. Daily Table Supermarket Specializes in Food Past Its Prime. *NBC Nightly News*, 29 June 2015. <http://www.nbcnews.com/nightly-news/food-past-its-prime-supermarket-specializes-expired-food-n383826>.

Mourad, M. 2016. Recycling, recovering and preventing "food waste": Competing solutions for food systems sustainability in the United States and France. *Journal of Cleaner Production* 126: 1–17.

Musulin, K. 2016. Canada unveils national plan to combat food waste. *WasteDive*. <http://www.wastedive.com/news/canada-unveils-national-plan-to-combat-food-waste/429795/>. Consulted October 2016.

———. n.d. Smaller portions, big benefits. Manage My Restaurant. <http://www.restaurant.org/Manage-My-Restaurant/Marketing-Sales/Food/Smaller-portions,-big-benefits>. Consulted Jul 2016.

National Consumers League Communications. 2016. New survey reveals how labeling contributes to food waste. *National Consumers League*. <http://www.nclnet.org/date_labeling_survey>. Consulted November 2016.

National Renderers Association. 2017. FAQs. < http://www.nationalrenderers.org/about/faqs/#what-is-nra>.

Naylor, R.. 2011. Expanding the boundaries of agricultural development. *Food Security* 3:233–251.

Neff, R.A., M.L. Spiker, and P.L. Truant. 2015. Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors. *Plos One* 10(6): e0127881. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0127881>. Consulted 16 June 2016.

Neighbourhood Group of Companies. 2016. Our Story. <http://www.neighbourhoodgroup.com/our-story>.

Not Far from the Tree. 2015. Giving back to our community, one fruit at a time. <http://notfarfromthetree.org/about/>.

NRA (National Restaurants Association). 2014. Gauging the Restaurant Industry's Interest in Sustainability. <http://conserve.restaurant.org/Downloads/PDFs/InterestInSustainability.aspx>. Consulted 17 August 2016.

———. 2015. What's Hot: 2016 Culinary Forecast. <http://www.restaurant.org/Downloads/PDFs/News-Research/WhatsHot2016>. Consulted July 2016.

NRDC (Natural Resources Defense Council). 2013. The Dating Game: How Confusing Labels Land Billions of Pounds of Food in the Trash. Harvard Food Policy Initiative, September 2013. <http://blogs.harvard.edu/foodpolicyinitiative/files/2013/09/dating-game-IB.pdf>.

Nwadike, L. 2016. How do food manufacturers pick those dates on their product packaging – And what do they mean? *The Conversation.* <https://theconversation.com/how-do-food-manufacturers-pick-those-dates-on-their-product-packaging-and-what-do-they-mean-60591>.

NZWC (National Zero Waste Council). 2015. *Study of Organic Waste Reduction: Tax Incentive Options for Charitable Food Donations – Making the Business Case.* Burnaby: National Zero Waste Council. <http://www.nzwc.ca/focus/food/FoodIncentives/NZWC-TaxIncentivesReportExecSummary.pdf>.

———. 2016. *Reducing Food Waste and Cutting Canada's Carbon Emissions: Policies for Reaping the Environmental, Economic and Social Benefits.* Burnaby: National Zero Waste Council. <http://www.nzwc.ca/focus/food/national-food-waste-strategy/Documents/NZWCSubmissionOnPan-CanadianFrameworkForCombattingClimateChange.pdf>. Consulted November 2016.

———. 2017. *Food Waste Management and Climate Action: National GHG Reduction Potential*. Burnaby: National Zero Waste Council. < http://www.nzwc.ca/focus/food/working-group/member-resources/FoodWorkingGroupDocs/FoodWasteClimateChange.pdf >.

Ontario Association of Food Banks. 2012. *Bill 36 – Tax Credit for Farmers.* <https://oafb.ca/hunger-in-ontario/policy/tax-credit-for-farmers/>.

Ontario Ministry of Agriculture, Food and Rural Affairs. 2016. *Food Processing and Preservation.* <http://www.omafra.gov.on.ca/english/food/industry/food_proc_guide_html/chapter_5.htm>. Consulted July 2016.

Ontario Waste Management Association. 2015. *Rethink Organic Waste.* Brampton: Ontario Waste Management Association.

Oregon State Government. 2016. Fact Sheet: SB 263 updates waste prevention, recycling requirements and goals. <http://www.oregon.gov/deq/LQ/Documents/SWdocs/SB263factsheet.pdf>. Consulted 28 July 2016.

Ornelas, S.L. 2015. Inside Mexico's Processed Food Industry: Appetizing Potential & Challenging Value Chain Recipe. *MexicoNow*, November–December. <http://www.mexicofoodsummit.com/docs/processed_food.pdf>.

Ostroff, J. 2016. How Canadian Technology Is Tackling The Food Waste Crisis. *The Huffington Post*, 28 June 2016 <http://www.huffingtonpost.ca/2016/06/28/canadian-food-waste_n_10661966.html>. Consulted July 2016.

Otten, J., S. Diedrich, K. Getts, and C. Benson. 2016. *Food Waste Prevention and Recovery Assessment Report*. University of Washington. <http://depts.washington.edu/uwcphn/reports/SeattleFoodWasteReport.PDF>. Consulted 21 June 2016.

PAC Food Waste. 2014. *Food Waste Reduction Case Studies*. Food Waste Packaging Solutions. September. <http://www.pac.ca/assets/2014-foodwaste-casestudies.pdf>.

Papargyropoulou, E., R. Lozano, J.K. Steinberger, N.l Wright, and Z. bin Ujang. 2014. The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production* 76: 106–115.

Parfitt, J., M. Barthel, and S. Macnaughton. 2010. Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of The Royal Society* B(365): 3065–3081.

Parry, A., P. Bleazard, and K. Okawa. 2015. Preventing Food Waste: Case Studies of Japan and the United Kingdom. *OECD Food, Agriculture and Fisheries Papers* 76.

Parsons, R. 2014. California farmers: How the state feeds a nation. *Los Angeles Times*, 12 March 2014. <http://www.latimes.com/food/dailydish/la-dd-calcook-california-its-whats-for-dinner-20140312-story.html>.

Patel, R. 2012. *Stuffed and Starved: The Hidden Battle for the World Food System.* Brooklyn: Melville House Pub.

Payne, M. 2012. Campus restaurants doing their share toward lowering waste. *The Daily Titan*, 22 March 2012. <http://www.dailytitan.com/2012/03/campus-restaurants-doing-their-share-toward-lowering-waste/>.

Paynter, B. 2017. Wholesome Wave Is Growing a Nationwide Network to Get Fresh Produce to People in Need. *Fast Company*, 9 March 2017. <https://www.fastcoexist.com/3068817/future-of-philanthropy/wholesome-wave-is-growing-a-nation-wide-network-to-get-fresh-produce->. Consulted 14 March 2017.

Pedroza Martínez, A. 2016. *La Industria Alimentaria Animal de México.* Mexico City: Conafab. <http://cic.zoga.com.mx/pdf/nutricion-La-Industria-Alimentaria-Animal-de-Mexico-2016.pdf>.

Perera, N., D. van Everdingen, D. Davies, J. Hundal, and J.P. Hettiaratchi. 2015. *Bioreactor Landfills – An Innovative Technology for Biostabilization of Municipal Solid Waste*. Environmental Services Association of Alberta. <http://www.esaa.org/wp-content/uploads/2015/06/05-Paper05.pdf>. Consulted 11 August 2016.

Perner, L. 2008. Distribution: Wholesaling and Retailing of Foods. University of Southern California Marshall. <http://www.consumerpsychologist.com/food_Distribution.html>. Consulted November 2016.

Perrault, D. 2016. *Selling unattractive food to decrease waste and encourage sustainable consumer behaviour in France: Lessons for Quebec food retailers.* Master's thesis. York University.

Pilotzi, J. 2017. Waste of food due to poor labeling. *El Economista*, 16 October 2017. <https://www.eleconomista.com.mx/opinion/Desperdicio-de-alimentos-por-mal-etiquetado-20171016-0150.html>.

Pingree, C. 2016. *Introducing commonsense bill to standardize food date labeling.* United States Congress. <https://pingree.house.gov/media-center/press-releases/introducing-commonsense-bill-standardaize-food-date-labelng>.

Pipatti, R., and P. Svardal. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Chapter 3: Solid Waste Disposal. <http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf>. Consulted 13 August 2016.

Popsugar. 2008. Food. You Waste, You Buy. 12 December 2008. <http://www.popsugar.com/food/Japanese-Buffet-Charge-Customers-Who-Dont-Finish-Food-2597515>. Consulted 24 February 2017.

Porter, J. 2014. How small plates have conquered America's menus. *Quartz*, 12 April 2014. <http://qz.com/196309/how-small-plates-have-conquered-americas-menus/>. Consulted July 2016.

Powers, J. 2016. *Special Report: America's Food Banks Say Charity Won't End Hunger*. Why Hunger. <https://whyhunger.org/images/publications/Special-Report.pdf>. Consulted July 2016.

Prentice, B.E. 2016. *Transport Airships for Northern Logistics: Technology for the 21st Century*. <https://www.tc.gc.ca/eng/ctareview2014/pdf/University%20of%20Manitoba%20-%20Asper%20School%20of%20Business%20-Transport%20Airships%20for%20Northern%20Transportation_final.pdf>.

Presidencia de la República. 2013. *Diario Oficial de la Federación.* 22 January. <http://dof.gob.mx/nota_detalle.php?codigo=5285363&fecha=22/01/2013>. Consulted June 14, 2016.

ProMéxico. 2015. Sectorial assessment—Processed food. Mexico.

Provision Coalition. 2016. Why Is Food Waste Important to Provision Coalition. <http://www.provisioncoalition.com/Resources/FoodWaste>. Consulted 26 July 2016.

Public Health Law Center. 2013. Liability Protection for Food Donation. Public Health Law Center at William Mitchell College of Law. <http://www.publichealthlawcenter.org/sites/default/files/resources/Liability%20Protection%20Food%20Donation.pdf>.

Quebec Ministry of Agriculture, Fisheries and Food. 2017. *Plan d'action de développement durable*. <https://www.mapaq.gouv.qc.ca/fr/Publications/PlanactionDevdurable.pdf>. Consulted 30 June 2017.

Queen's University. 2011. *Queen's University Waste Audit Summary January 2011.* Kingston: Queen's University.

Quested, T., and A. Parry. 2011. *New estimates for household food and drink waste in the UK.* Waste and Resources Action Programme.

Ramírez, L.. 2014. La Promoción de un Buen Manejo de Post Cosecha en el Campo Mexicano. *Enlace* 5(18): 14.

Recycling Council of Ontario. n.d. 3RCertified™ Waste Reduction & Diversion Program. <https://www.rco.on.ca/3rcertified>. Consulted 12 August 2016.

RedHat Co-operative Ltd. n.d. RedHat Co-operative Ltd. <http://www.redhatco-op.com/>. Consulted July 2016.

ReFED (Rethink Food Waste through Economics and Data). 2016. *A Roadmap to Reduce US Food Waste by 20 Percent*. Consulted 22 June 2017. < https://www.refed.com/downloads/ReFED_Report_2016.pdf>.

———. 2016. *A Roadmap to Reduce US Food Waste by 20 Percent – Technical Appendix*. <https://www.refed.com/downloads/ReFED_Technical_Appendix.pdf>. Consulted 22 June 2017.

———. 2017a. Animal Feed Definition. < https://www.refed.com/solutions/animal-feed>.

———. 2017b. Secondary Resellers Definition. < http://www.refed.com/solutions/secondary-resellers>.

———. 2017c. HFLPC Policy Chart: States Regulating Date Labeling. <http://www.refed.com/img/downloads/ReFED_HFLPC_Policy_Chart.pdf>.

———. 2017d. The Food Waste Innovator Database. <http://www.refed.com/tools/innovator-database/?mc_cid=6e2c0369f2&mc_eid=67beb7742c>. Consulted April 2017.

———. 2017e. US Food Waste Policy Finder.. <http://www.refed.com/tools/food-waste-policy-finder/?mc_cid=6e2c0369f2&mc_eid=67beb7742c>. Consulted April 2017.

Regional District of Nanaimo. 2013. *Commercial Food Waste Diversion.* <http://www.rdn.bc.ca/cms.asp?wpID=1068>. Consulted 4 August 2016.

Research Triangle Institute International. 2012. Municipal Solid Waste Decision Support Tool. <https://mswdst.rti.org/>. Consulted 20 April 2017.

Reyes, E. 2015. Deperdicio de Alimentos en Supermercados. *Mundo HVACR.*

Rhode Island Resource Recovery Corporation. 2015. *Rhode Island Solid Waste Characterization Study*. <www.rirrc.org/content/getfile.php?o=document&id=540>. Consulted August 2016.

Rich, T. 2014. An Overview of Canadian Food Availability Estimates. *The National Academy of Sciences.* Washington DC: The National Academies Press.

Riis, J. 2014. Opportunities and barriers for smaller portions in foodservice: Lessons from marketing and behavioral economics. *International Journal of Obesity*, 38 July 2014 (Suppl 1): S19–24.

Robbins, T. 2014. The Fruits of Free Trade: How NAFTA Revamped the American Diet. *The Salt*, 9 January 2014. <http://www.npr.org/sections/thesalt/2014/01/09/260790888/the-fruits-of-free-trade-how-nafta-revamped-the-american-diet>. Consulted October 2016.

Rogers, N. 2013. Doing Away with the Tray. <http://www.sustainableamerica.org/blog/doing-away-with-the-tray/>. Consulted July 2016.

Romero, A. 2013. Gestión Integral de Residuos Sólidos Urbanos de la CEDA. Mexico Low Emissions Development Program. Documentos. <http://www.mledprogram.org/documentos/gestion-integral-de-residuos-solidos-urbanos-de-la-ceda.html>. Consulted 24 May 2016.

Roychoudhuri, O. 2008. Michael Pollan Debunks Food Myths. <http://michaelpollan.com/interviews/michael-pollan-debunks-food-myths/>. Consulted July 2016.

Rutten, M. 2013. What economic theory tells us about the impacts of reducing food losses and/or waste: Implications for research, policy and practice. *Agriculture & Food Security* 2(13).

Sagarpa (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación). 2010. *Retos y oportunidades del sistema agroalimentario de México en los próximos 20 años.* Sagarpa, Mexico.

———. 2015. *Diario Oficial de la Federación.* December 30. <http://www.sagarpa.gob.mx/agricultura/Programas/proagro/Normatividad/Documents/2016/Reglas_Operacion_2016_sagarpa_DOF_OFICIAL.pdf>. Consulted 9 June 2016.

———. n.d. *Aprovechamiento de esquilmos y subproductos en la alimentación del ganado.* <http://www.sagarpa.gob.mx/desarrolloRural/Documents/fichasaapt/Aprovechamiento%20de%20esquilmos.pdf>. Consulted 30 June 2017.

Sakaguchi, L. 2016. Food Waste in Berkeley Restaurants. Paper presented at the annual meeting and conference of ASFS AFHVS/CAFS, Toronto, Ontario, 22–25 June 2016.

Sánchez, A. 2008. Al comer, la porción si importa. *Revista del Consumidor, PROFECO*: 57–59.

Sauve Ta Bouffe. 2017. *Sauve Ta Bouffe – Our actions*. <http://www.sauvetabouffe.org/le-projet/nos-actions-2/>. Consulted 27 February 2017.

Save Food. 2017. Mission – Save Food. < http://www.fao.org/save-food/background/en/>. Consulted October 2016.

Schneider, F. 2013. The evolution of food donation with respect to waste prevention. *Waste Management* 33(3): 755–763.

Schwartz, J., J. Riis, B. Elbel, and D. Ariely. 2012. Inviting Consumers to Downsize Fast-Food Portions Significantly Reduces Calorie Consumption. *Health Affairs*, 2 April 2012.

Schwegler, P. 2014. Economic valuation of environmental costs of soil erosion and the loss of biodiversity and ecosystem services caused by food wastage. *Journal of Socio Economics in Agriculture* 8(2). <http://archive.jsagr.org/v7/YSA2014_Schwegler.pdf>. Consulted 12 July 2016.

Sealed Air. 2015. *Packaging Digest.* <http://magazine.progressivegrocer.com/i/461479-sealed-air-2015/5>. Consulted 22 June 2016.

Searchinger, T., C. Hanson, J. Ranganathan, B. Lipinski, R. Waite, R. Winterbottom, A. Dinshaw and R. Heimlich. 2013. *The Great Balancing Act.* World Resources Institute. <http://www.wri.org/sites/default/files/great_balancing_act.pdf>. Consulted 7 August 2016.

Seattle Public Utilities. 2016. *Food Waste Prevention and Recovery Assessment Report.* Seattle Public Utilities, and The City of Seattle's Office of Sustainability and Environment.

Second Harvest. 2014. Food Donor Info. <http://www.secondharvest.ca/sites/secondharvest.ca/files/FOOD%20DONOR%20PACKAGE%202014.pdf>.

Second Harvest Food Bank. 2017. Food Donor Liability Protection. Second Harvest Food Bank of Southern Wisconsin. <http://www.secondharvestmadison.org/get-involved/foodfund-drives/food-donor-liability-protection>. Consulted 15 March 2017.

Sectur (Secretaría de Turismo). 2016. *Apoya SECTUR Programa "Al Rescate" Que Atenderá A Grupos Vulnerables A Través De Banco De Alimentos*. 16 November. Secretaría de Turismo. <http://www.gob.mx/sectur/prensa/comunicado-200>.

Sedesol (Secretaría de Desarrollo Social). 2013. Sin Hambre. 15 October. <http://sinhambre.gob.mx/wp-content/uploads/2014/03/Minuta-7-Sesi%C3%B3n-GT-Merma-y-Desperdicio.pdf>. Consulted 27 July 2016.

———. 2016. Fondo de Aportaciones para la Infraestructura Social (FAIS). 1 April. <http://www.sedesol.gob.mx/en/SEDESOL/Informes_FAIS>. Consulted 19 June 2017.

Selman, M., and S. Greenhalg. 2009. *Eutrophication: Sources and Drivers of Nutrient Pollution.* WRI Policy Note. Washington, DC: World Resources Institute.

Semarnat (Secretaría de Medio Ambiente y Recursos Naturales). 2011. Standard NOM-161-SEMARNAT-2011. *Diario Oficial de la Federación*. 2 January 2011. <http://www.profepa.gob.mx/innovaportal/file/6633/1/nom-161-semarnat-2011.pdf>.

———. 2013. National Strategy on Sustainable Production and Consumption. <http://www.semarnat.gob.mx/sites/default/files/documentos/fomento/documentos/2014/ENPCS.pdf>. Consulted 30 June 2017.

———. 2014. Special Program of Sustainable Production and Consumption <http://www.dof.gob.mx/nota_detalle.php?codigo=5342495&fecha=28/04/2014>. Consulted 28 June 2016.

———. 2016. Documentos relativos al Programa U012 Gestión Integral de Residuos. <https://www.gob.mx/semarnat/documentos/documentos-relativos-al-programa-u012-gestion-integral-de-residuos>.

Senado de le República. 2016. <http://comunicacion.senado.gob.mx/index.php/informacion/boletines/30999-senadoras-proponen-crear-el-consejo-nacional-para-el-aprovechamiento-de-alimentos.html >.

Senasica (Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria). 2016. *Sistema de información de consulta de plantas autorizadas*. <https://sistemasssl.senasica.gob.mx/PlantaAcreditada/>.

Serecon Management Consulting. 2005. *Canadian Food – Trends to 2020 – A Long Range Consumer Outlook.* Ottawa: Agriculture and Agri-Food Canada.

Shattuck, A., E. Holt-Giménez, H. Herren, M. Altieri, and S. Gliessman. 2012. We already grow enough food for 10 billion people...and still can't end hunger. *Journal of Sustainable Agriculture* 36(6): 595–598.

Sheely, M. 2008. Global Adoption of Convenience Foods. American Journal of Agricultural Economics 90(5): 1356–1365.

Shoffstall, G., and Z. Gille. 2015. From the nano to the global scale: New utopian solutions to food waste (Chapter 3). In *Food Utopias: Reimagining Citizenship, Ethics and Community*. London: Routledge.

SIAP (Servicio de Información Agroalimentaria y Pesquera). 2017. ¿Qué hacemos?. <http://www.gob.mx/siap/que-hacemos>. Consulted April 2017.Seto, Karen C., Michail Fragkias, Burak Güneralp, and Michael K. Reilly. 2011. A Meta-Analysis of Global Urban Land Expansion. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0023777>. Consulted October 2016.

SIPSE. 2016. México, a la vanguardia en alimentos limpios. <http://sipse.com/mexico/mexico-a-la-vanguardia-en-produccion-y-exportador-alimentos-sanos-198836.html>. Consulted May 2017.

Slow Food Mexico. 2017. What Do We Do? <www.slowfood.mx/que-hacemos/>. Consulted 20 March 2017.

Smith, S.L., and L. Cunningham-Sabo. 2013. Food choice, plate waste and nutrient intake of elementary- and middle-school students participating in the US National School Lunch Program. *Public Health Nutrition* 1–9. <www.fshn.chhs.colostate.edu/reseaxrch/scopl/foodchoice_platewaste_phnpaper.pdf>.

Smulders, M. 2008. Tray-spotting. *Dalhousie University News*, 3 March 2008. <http://www.dal.ca/news/2008/03/03/tray.html>.

South Carolina Department of Commerce. 2015. *South Carolina Food Waste Generation Report*. <http://www.recyclinginsc.com/sites/default/files/all/scfoodwastegeneration_summary.pdf>.

Sparling, D., and E. Cheney. 2014. *The Performance of Canada's Food Manufacturing Industry*. <http://www.capi-icpa.ca/pdfs/2014/CAPI-PFRP_P3a.pdf>. Consulted July 2016.

Specific Mitigation Opportunities Working Group. 2016. *Specific Mitigation Opportunities Working Group: Final Report*. <http://www.climatechange.gc.ca/Content/6/4/7/64778DD5-E2D9-4930-BE59-D6DB7DB5CBC0/WG_Report_SPECIFIC_MITIGATION_OPPORTUNITIES_EN_V04.pdf>. Consulted April 2017.

Spooner, B. 2016. Food Waste and Food Security in a Globalizing World. In *Food Waste Across the Supply Chain: A US Perspective on a Global Problem*: 68–81.

Statistics Canada. 2009. Section 1: Food in Canada. <http://www.statcan.gc.ca/pub/16-201-x/2009000/fnpart-fnpartie1-eng.htm#fn7>. Consulted July 2016.

———. 2011. Population, urban and rural, by province and territory (Canada). Table. <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62a-eng.htm>.

———. 2014. Canadian Business Patterns Database. Ottawa: Statistics Canada.

———. 2015. Health at a Glance: Food insecurity in Canada. 25 March. <https://www.scribd.com/document/260080624/Statistics-Canada-Food-Insecurity-in-Canada>.

———. 2016. Canadian business counts, location counts with employees, by employment size and North American Industry Classification System (NAICS), Canada and provinces, December 2016. CANSIM < http://bit.ly/2rnk99C>. Consulted June 2017.

———. 2017a. Estimated areas, yield, production and average farm price of principal field crops, in metric units. Cansim. <http://www5.statcan.gc.ca/cansim/a26>. Consulted April 2017.

———. 2017b. Annual retail trade survey, financial estimates by North American Industry Classification System (NAICS) and store type. Cansim. <http://www5.statcan.gc.ca/cansim/a47>. Consulted April 2017.

———. 2017c. Monthly survey of food services and drinking places, by North American Industry Classification System (NAICS). Cansim. <http://www5.statcan.gc.ca/cansim/a47>. Consulted April 2017.

Stewart, H, N. Blisards, S. Bhuyan, and R.M.Nayga, Jr. 2004. *The Demand for Food Away From Home: Full-Service or Fast Food?* United States Department of Agriculture Agricultural Economic Report No. 829. <https://www.ers.usda.gov/webdocs/publications/aer829/15272_aer829_1_.pdf?v=41055>.

Strasser, S. 2000. *Waste and Want.* New York, NY: Henry Holt and Company, LLC.

Strom, S. 2016. New Crop of Companies Reaping Profits From Wasted Food. *The New York Times*, 24 May 2016. <http://www.nytimes.com/2016/05/26/business/energy-environment/new-crop-of-companies-reaping-profits-from-wasted-food.html?_r=0>.

Stuart, T. 2009. *Waste – Uncovering the global food scandal.* London: Penguin Books.

Sullivan, E. 2013. At Fred's Market buffet, it pays to clean your plate. *Tampa Bay Times*, 2 May. <http://www.tampabay.com/news/business/at-freds-market-buffet-it-pays-to-clean-your-plate/2118572>. Consulted 24 February 2017.

Suttle, R. n.d. What is the Meaning of Retail Food. *Chron Small Business*. <http://smallbusiness.chron.com/meaning-retail-food-17255.html>. Consulted October 2016.

Tamminga, M. 2015. Aiming to Secure World's Food Supply. *Langley Times*, 24 September 2015. <http://www.langleytimes.com/business/329225591.html>. Consulted 16 November 2016.

Tarasuk, V. 2015. Donating 'edible waste' to food banks in exchange for tax credit? Now that's a rubbish idea. *The Globe and Mail*, 11 February 2015.

Tarasuk, V., and J.M. Eakin. 2005. Food assistance through "surplus" food: Insights from an ethnographic study of food bank work. *Agriculture and Human Values* 22: 177–186.

Tavill, G. 2017. Breaking Down Economic Barriers of Food Waste Reduction. Presentation at the North American Workshop on Food Waste Reduction and Recovery, 28 February–2 March 2017.

Tenorio, J. 2016. Presentation of Agrifood and Livestock Information. Seminario técnico de medición y análisis de pérdidas de alimentos en México – Magnitud, causas y soluciones Ciudad de México.

Tesco. n.d. Reducing food waste. <https://www.tescoplc.com/tesco-and-society/reducing-food-waste>. Consulted 1 August 2016.

The Daily Table. 2015. < http://dailytable.org/>. Consulted 30 June 2017.

Thomspon, T. 2016. Food exports surpass oil for Mexico. <http://producenews.com/the-produce-news-today-s-headlines/18727-food-exports-surpass-oil-for-mexico>. Consulted October 2016.

Thyberg, K., D. Tonjes, and J. Gurevitch. 2015. Quantification of Food Waste Disposal in the United States: A Meta-Analysis. *Environ. Sco.Technol.* 49(24): 13946–13953.

Thyberg, K.L, and D.J. Tonjes. 2016. Drivers of food waste and their implications for sustainable policy. *Resources, Conservation and Recycling* 106: 110–123.

Toller, C. 2015. How a new wave of food entrepreneurs hope to persuade us to eat bugs. *Canadian Business*, 11 June 2015. <http://www.canadianbusiness.com/innovation/eat-bugs/>. Consulted July 2016.

Torre, M. De la. 2008. NOTAS No. 112-Instituto Mexicano del Transporte. <http://imt.mx/resumen-boletines.html?IdArticulo=319&IdBoletin=113>. Consulted 11 June 2016.

Toth, J.D., and E.Z. Dou. 2016. Wasted Food, Wasted Resources: Land, Irrigation Water, and Nutrients Associated with Food Wastage in the US. In *Food Waste Across the Supply Chain: A US Perspective on a Global Problem*, E.Z. Dou, J.D. Ferguson, D.T. Galligan, A.M. Kelly, S.M. Finn and R. Giegengack (eds.). Ames, IA, USA: Council for Agricultural Science and Technology.

Touzalin, J. 2016. Some molds you can eat. This one, you shouldn't. *The Washington Post*, 17 February 2016. <https://www.washingtonpost.com/lifestyle/food/some-molds-you-can-eat-this-one-you-shouldnt/2016/02/17/7e4850c4-d508-11e5-9823-02b905009f99_story.html>.

UK Parliament. 2012. *Written evidence submitted by WRAP*.. <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/879/879vw20.htm>.

———. 2014. Prevention and reduction of food and drink waste in businesses and households – Guidance for governments, local authorities, businesses and other organisations, Version 1.0. <http://www.thinkeatsave.org/downloads/UNEP-FW-Guidance-content-VERSION-WEB.pdf>. Consulted 17 August 2016.

———. 2017. The 10-Year Framework of Programmes on Sustainable Production and Consumption. <http://www.unep.fr/scp/pdf/10YFP_english.pdf>. Consulted June 2017.

UN Sustainable Development. 2015. Goal 12: Ensure sustainable consumption and production patterns. <http://www.un.org/sustainabledevelopment/sustainable-consumption-production/>. Consulted 26 October 2016.

UNEP (United Nations Environment Programme). 2013. Think, Eat, Save: UNEP, FAO and Partners Launch Global Campaign to Change Culture of Food Waste. *UNEP News Centre*. <http://www.unep.org/NEWSCENTRE/default.aspx?DocumentId=2702&ArticleId=9377>. Consulted November 2016.

United Nations Conference on Trade and Development. 2014. Mexico's Agricultural Development: Perspectives and Outlook. <http://unctad.org/en/PublicationsLibrary/ditctncd2012d2_rev1_en.pdf>. Consulted July 2016.

University Affairs Canada. 2015. The campus food revolution. *University Affairs Canada*, 15 March. <http://www.universityaffairs.ca/features/feature-article/the-campus-food-revolution/>.

University of Alberta. 2014. *Food and Dining: Sustainability Plan.* December. <http://sustainability.ualberta.ca/GetInvolved/SustainabilityPlan/~/media/sustainability/Plan/2015/Backgrounders/06_FoodDining.pdf>.

University of Arkansas (UARK). 2013. *Legal Guide to Food Recovery*. <https://law.uark.edu/documents/2013/06/Legal-Guide-To-Food-Recovery.pdf>. Consulted 30 June 2017.

University of British Columbia. 2014. *University of British Columbia OP-T2-3: Trayless Dining.* <https://stars.aashe.org/institutions/university-of-british-columbia-bc/report/2011-08-02/OP/dining-services/OP-T2-3/>.

University of Washington Center for Public Health Nutrition. 2016. *Food Waste Prevention and Recovery Assessment Report*. <http://depts.washington.edu/uwcphn/reports/SeattleFoodWasteReport.PDF>. Consulted 21 June 2016.

USDA (United States Department of Agriculture). 2012. *Agricultural Statistics.* Washington DC: US Government Printing Office.

———. 2015. USDA and EPA Join with Private Sector, Charitable Organizations to Set Nation's First Food Waste Reduction Goals. <http://www.usda.gov/wps/portal/usda/usdahome?contentid=2015/09/0257.xml>. Consulted 28 July 2016.

———. 2016a. Commodity Standards and Grades.. <http://www.usda.gov/wps/portal/usda/usdahome?navid=COMMODITY_STANDARDS>. Consulted July 2016.

———. 2016b. Plate Waste. January. <http://www.fns.usda.gov/sites/default/files/ops/HHFKA-PlateWaste.pdf>. Consulted July 2016.

———. 2016c. *Milk Production, Disposition, and Income: 2015 Summary*. USDA National Agricultural Statistics Service. <http://usda.mannlib.cornell.edu/usda/current/MilkProdDi/MilkProdDi-04-28-2016.pdf>.

———. 2016d. Retail Trends. <https://www.ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/retail-trends/>.

USDA ERS (Economic Research Service). 2009. Food Availability (per capita) Data System. United States Department of Agriculture, Economic Research Service. <http://www.ers.usda.gov/Data/FoodConsumption>. Consulted 6 August 2016.

———. 2012. National Agricultural Statistics Service. <http://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/agricultural-production-and-prices.aspx>. Consulted 22 June 2016.

———. 2015. *Household Food Security in the United States in 2015*. United States Department of Agriculture, Economic Research Service. <https://www.ers.usda.gov/publications/pub-details/?pubid=79760>.

———. 2016a. Manufacturing: Food and beverage manufacturing. <http://www.ers.usda.gov/topics/food-markets-prices/processing-marketing/manufacturing.aspx>. Consulted November 2016.

———. 2016b. Retailing and Wholesaling. <http://ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/retail-trends.aspx>. Consulted 22 June 2016.

———. 2016c. Food Prices and Spending. 15 August. <https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-prices-and-spending/>. Consulted 8 March 2017.

———. 2016d. *Opportunities for Making U.S.-Mexico Agricultural Trade More Agile*. <https://www.ers.usda.gov/webdocs/publications/74665/60240_eib-160.pdf?v=42604>.

USDA FAS (Foreign Agricultural Service). 2010. *Global Agricultural Information Network Report – Mexico Revises Food Labeling Regulations*. <https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Mexico%20Revises%20Food%20Labeling%20Regulations_Monterrey%20ATO_Mexico_6-17-2010.pdf>.

———. 2014. *Global Agricultural Information Network Report – An Updated Overview of the Canadian Food Processing Sector*. <https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Food%20Processing%20Ingredients_Ottawa_Canada_12-17-2014.pdf>.

USDA FSIS (Food Safety and Inspection Service). 2016. Food Product Dating. Food Safety and Inspection Service. <https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/food-product-dating/food-product-dating>. Consulted 24 February 2017.

US EPA (United States Environmental Protection Agency). 2005. *Landfill Gas Emissions Model (LandGEM) Version 3.02 User's Guide*. <https://www3.epa.gov/ttncatc1/dir1/landgem-v302-guide.pdf>. Consulted 13 August 2016.

———. 2010. *Greenhouse Emissions Estimation Methodologies for Biogenic Emissions from Selected Source Categories: Solid Waste Disposal, Wastewater Treatment, Ethanol Fermentation*. 14 December. <https://www3.epa.gov/ttnchie1/efpac/ghg/GHG_Biogenic_Report_draft_Dec1410.pdf>. Consulted 15 August 2016.

———. 2013. An Overview of Landfill Gas Energy in the United States. US EPA Landfill Methane Outreach Program. July. Consulted 8 August 2016.

———. 2014. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures: A Methodology Document. <https://www.epa.gov/sites/production/files/2015-12/documents/methodolgy_document_for_selected_municipal_solid_waste_products.pdf>. Consulted 28 November 2017.

———. 2015a. *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM).* Environmental Protection Agency. <https://www3.epa.gov/warm/pdfs/WARM_Documentation.pdf>. Consulted 13 August 2016.

———. 2015b. LFG Energy Project Development Handbook, in Landfill Methane Outreach Program. < https://www.epa.gov/lmop/landfill-gas-energy-project-development-handbook-files>. Consulted August 2016.

———. 2016a. Food Recovery Hierarchy. <https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy>. Consulted July 2016.

———. 2016b. A Call to Action by Stakeholders: United States Food Loss & Waste 2030 Reduction Goal. 26 July. <https://www.epa.gov/sustainable-management-food/call-action-stakeholders-united-states-food-loss-waste-2030-reduction>. Consulted 28 July 2016.

———. 2016c, November. Advancing Sustainable Materials Management: 2014 Fact Sheet. <https://www.epa.gov/sites/production/files/2016-11/documents/2014_smmfactsheet_508.pdf>. Consulted November 2016.

———. 2016d. Bioreactor Landfills – US EPA Landfill Methane Outreach Program. May <https://www.epa.gov/landfills/bioreactor-landfills#projects>. Consulted August 2016.

———. 2016e. Advancing Sustainable Materials Management: Facts and Figures – U.S. State and Local Waste and Materials Characterization Reports. < https://www.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures>. Consulted July 2016.

———. 2016f. EPA's Initiatives and Data on Wasted Food – Wasted FOOD Mapping Initiative. August. <https://classic.regonline.com/custImages/290000/291337/Mooney_EPA_Ohio.pdf>. Consulted February 2017.

———. 2017a, February 15. *DRAFT: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2015*. <https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf>.

———. 2017b. Greenhouse Gas Equivalencies Calculator. 24 January. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.

———. 2017c. Food Recovery Challenge Results and Award Winners. <https://www.epa.gov/sustainable-management-food/food-recovery-challenge-results-and-award-winners>. Consulted April 2017.

US Government Publishing Office. 1996. Public Law 104-210-Oct. 1, 1996. <https://www.congress.gov/104/plaws/publ210/PLAW-104publ210.pdf>.

US Grains Council. 2017. U.S. Grains in All Forms Exports. < https://www.grains.org/market-data/feed-grain-exports-in-all-forms>. Consulted 20 February 2017.

Uzea, N., M. Gooch, and D. Sparling. 2014. *Developing an Industry Led Approach to Addressing Food Waste in Canada.* Guelph: Provision Coalition. <http://www.provisioncoalition.com/assets/website/pdfs/Provision-Addressing-Food-Waste-In-Canada-EN.pdf>.

Value Chain Management International. 2012. *Cut Waste, Grow Profit: How to reduce and manage food waste, leading to increased profitability and environmental sustainability*. Value Chain Management Centre International. 19 November. <http://vcm-international.com/wp-content/uploads/2013/05/Cut-Waste-Grow-Profit-FINAL-DOCUMENT-Oct-3-12.pdf>.

Venkat, K. 2011. The Climate Change and Economic Impacts of Food Waste in the United States. *International Journal on Food System Dynamics* 2(4): 431–446.

Verghese, K, H. Lewis, S. Lockrey, and H. Williams. 2013. *The role of packaging in minimising food waste in the supply chain of the future.* CHEP Australia, Melbourne: RMIT University.

Vermeulen, S.J., B.M. Campbell, and J.S.I. Ingram. 2012. Climate Change and Food Systems. *Annual Review of Environmental Resource* 37: 195–222.

Vyhnak, C. 2014. Opinion: Why do restaurants just pile it on? *The Star*, 4 August 2014. <https://www.thestar.com/news/insight/2014/08/01/opinion_why_do_restaurants_just_pile_it_on.html>.

Wageningen University and Research, and Sagarpa. 2014. *Programa Nacional de Agrologística.* Estudio: Sagarpa.

Wansink, B., and K. van Ittersum. 2006. The visual illusions of food: Why plates, bowls, and spoons can bias consumption volume. *FASEB Journal* 20.

———. 2007. Portion Size Me: Downsizing Our Consumption Norms. *Journal of the American Dietetic Association*, July 2007.

<http://foodpsychology.cornell.edu/sites/default/files/unmanaged_files/portion_size_me_JADA_2007.pdf>.

Washington State Department of Ecology. 2010. *2009 Washington Statewide Waste Characterization Study*. <https://fortress.wa.gov/ecy/publications/documents/1007023.pdf>. Consulted August 2016.

Washington State University. 2011. Annual income spent on food. <http://wsm.wsu.edu/researcher/wsmaug11_billions.pdf>. Consulted November 2016.

White House, Office of the Press Secretary. 2016. North American Climate, Clean Energy, and Environment Partnership Action Plan. <https://www.whitehouse.gov/the-press-office/2016/06/29/north-american-climate-clean-energy-and-environment-partnership-action>.

Whole Vine. 2016. About Us. <http://www.wholevine.com/our-story-roots/>. Consulted July 2016.

Wiley Online Library. 2016. Definition – Food Industry. <http://onlinelibrary.wiley.com/cochranelibrary/search/mesh?searchRow.searchOptions.conceptId=D019649&searchRow.searchCriteria.meshTerm=Food%20Industry&meshConcept=Update&searchRow.ordinal=0&hiddenFields.strategySortBy=last-modified-date;desc&hiddenFields.showStrategies=false>. Consulted October 2016.

Wood, M. 2008. Tangy, Junior-size Fruit Bars from ARS Process. <http://www.ars.usda.gov/is/pr/2008/080618.htm>. Consulted July 2016.

World Bank. 2015a. Feature Story: Eyes Bigger than Belly: A habit which is harming Latin America. <http://www.worldbank.org/en/news/feature/2015/11/12/food-waste-habit-harming-latin-america>. Consulted 7 July 2016.

———. 2015b. Population Density (people per sq. km of land area). <http://data.worldbank.org/indicator/EN.POP.DNST?end=2015&locations=US-CA&name_desc=true&start=2015&view=bar>. Consulted November 2016.

Worley, K. 2014. *Walmart's Landfill Waste Reduction, the Organics Solutions*. Food Waste Reduction Alliance. <http://www.foodwastealliance.org/wp-content/uploads/2014/07/Walmart_organics-case-study_FWRA_07212014.pdf>.

WRAP (Waste and Resources Action Programme). 2010. Waste arisings in the supply of food and drink to households in the UK. <http://www.wrap.org.uk/sites/files/wrap/Waste%20arisings%20in%20the%20supply%20of%20food%20and%20drink%20toUK%20households,%20Nov%202011.pdf>. Consulted July 2016.

———. 2013a. Estimates of waste in the food and drink supply chain. <www.wrap.org.uk/sites/files/wrap/Estimates of waste in the food and drink supply chain_0.pdf>. Consulted July 2016.

———. 2013b. *Household Food and Drink Waste in the United Kingdom 2012*.. <http://www.wrap.org.uk/sites/files/wrap/hhfdw-2012-main.pdf.pdf>.

——-. 2015. Reducing food waste could save the global economy $300 billion a year. <http://www.wrap.org.uk/content/reducing-food-waste-could-save-global-economy-300-billion-year>. Consulted 26 July 2016.

———. 2016a. *The Courtauld Commitment 2025 to transform UK food and drink.* Waste and Resources Action Programme.

———. 2016b. *Quantification of food surplus, waste and related materials in the grocery supply chain.* London: Waste and Resources Action Programme.

———. 2017. Measuring GHG savings from food waste reduction and recovery. Presentation at North American Workshop on Food Waste Reduction and Recovery, Toronto, Ontario, 28 February–2 March 2017.

———. n.d.a. The Courtauld Commitment: What is It? <http://www.wrap.org.uk/node/14507>. Consulted 26 July 2016.

———. n.d.b. Supporting resources for the Hospitality and Food Service sector. Waste and Resources Action Programme. <http://www.wrap.org.uk/content/supporting-resources-hospitality-and-food-service-sector-3>. Consulted November 2016.

———. n.d.c. What is Courtauld 2025. Waste and Resources Action Programme. <http://www.wrap.org.uk/content/what-courtauld-2025>. Consulted November 2016.

WRI (World Resources Institute). 2013. *Reducing Food Loss and Waste – Working Paper*. *Creating a Sustainable Food Future, Installment 2*. World Resources Institute.

WRI (World Resources Institute), FLW Protocol Steering Committee. 2016. *Food loss and waste accounting and reporting standard*. Version 1.0. Washington, DC: World Resources Institute.

Wright, T. 2007. *The Average Amount of Solid Food Waste Produced at the Howe Hall Cafeteria and an Investigation of its Causes*. Halifax: Dalhousie University.

York Region Food Network. n.d. Fresh Food Partners Gleaning Program. <http://yrfn.ca/programs/fresh-food-partners-gleaning-program/>.

Young, L.R., and M. Nestle. 2003. Expanding portion sizes in the US marketplace: Implications for nutrition counseling. *Journal of The American Dietetic Association* 103.

———. 2012. Reducing Portion Sizes to Prevent Obesity: A Call to Action. *American Journal of Preventive Medicine* 43(5): 565–568.