

## Spotlight

# FOOD WASTE

Laying Waste to Waste:  
Tackling Consumer-level  
Food and Food-related  
Waste in Canada

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**INNOVATIVE.  
INTERDISCIPLINARY.  
INSIGHTFUL.**

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# **ABOUT ARRELL FOOD INSTITUTE**

The University of Guelph is a world leader in food and agricultural innovation. Arrell Food Institute at the University of Guelph harnesses multidisciplinary expertise, convenes dialogues, and publishes papers on timely and relevant topics.

Food is intrinsic to human, economic, and planetary health; yet, it rarely comes first in conversations about how to meet today's challenges. Arrell Food Institute at the University of Guelph exists to elevate food to improve life. We bring people together to conduct research, train the next generation of food leaders, and shape social, industrial, and governmental decisions, always ensuring food is the central priority.

More information about the Arrell Food Institute can be found at:  
[\*\*arrellfoodinstitute.ca\*\*](http://arrellfoodinstitute.ca)

**OUR MISSION: ELEVATE FOOD TO IMPROVE LIFE.**

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# EXECUTIVE SUMMARY



Food waste is one of the most significant sustainability challenges we face today. In 2019, Gooch et al. estimated that 35.5 million metric tonnes of food were lost or wasted annually in Canada. This accounts for 58% of all food produced in Canada—or an estimated 50 billion dollars. Food isn't the only challenge; waste from food packaging also represents a significant issue. In Canada, food packaging makes up about one-third of a household's waste—3.4 million tonnes of waste each year. At best, about 20% of packaging products are reused or recycled; the remaining 80% ends up as litter or in landfills.<sup>2,3</sup>

Are consumers able to reduce food waste? Do they feel pressured to reduce food waste? Are they able to reduce the waste associated with food consumption, i.e., food-related waste? This report describes food and food-related waste in Canada, discusses consumer behaviours that lead to food and food-related waste, and reviews some consumer-targeted opportunities and recommendations for reducing the amount of waste we produce. We explore these challenges by evaluating the role and relationships between knowledge, attitudes, social norms, and perceived control over behaviour.

Research on consumer behaviour has shown that attitudes towards waste tend to be one of the biggest factors influencing consumers.<sup>4,5</sup> In many cases, consumers are ambivalent about waste; they don't want to waste food but typically view the impact as minor, or don't understand its full impact. Household food norms and consumer relationships with food are also changing; in an "on the go" society, consumers expect convenience. Consumers may misunderstand the meaning of open date labels such as use-by and best-by, which can lead to additional food waste. Lastly, control over food waste and food-related waste is complicated—it depends on socio-demographic factors as much as on willingness to prevent waste, and multifaceted, nuanced factors drive consumer decisions.

Given the complex nature of this problem, there is no 'silver bullet' solution. Education and awareness campaigns at the municipal, provincial, and federal level led by governmental organizations or industry will need to emphasize the true impact of waste and offer practical solutions for minimizing it. Most importantly, these strategies must change consumer mindsets towards food. Governments and the private sector must look at current regulations and policies to facilitate and incentivize innovative approaches towards minimizing waste and

enforce penalties and disincentives for those who do not adapt. More research is also needed to better understand the factors influencing consumers and potential solutions to this global issue. In a world challenged to sustainably feed approximately 9.7 billion people by 2050, tackling food waste is a problem we cannot afford to ignore.

# CURRENT CONTEXT

Over the last fifty years, there have been significant improvements in our food system. Farmers today produce more food using less land, labour, energy, and water than ever before. Supply chains are more sophisticated and can handle and distribute larger volumes of food over greater distances. As a result, food is safer, more accessible, more diverse, and more affordable than ever before. Despite these improvements, historical problems in our food system persist, and new ones have emerged. With finite resources available, one of the major concerns is whether our current food system will be able to meet the demands of a growing population. Globally, it is estimated that there will be an additional 2 billion people to feed by 2050. Eating is an essential part of human life, and tackling sustainability problems associated with the production, consumption, and disposal of food is an important challenge over the next thirty years.

One of the most significant sustainability challenges in our current food system is food waste. Every year, approximately one-third of the food we produce is wasted.<sup>6</sup> This stems from overproduction, product mishandling and damage, lack of proper storage, rigid food-grading specifications, varying consumer demand, and market fluctuations.<sup>7</sup> The United Nations Food and Agriculture Organization (FAO) estimates that this waste amounts to approximately 1.3 billion tonnes of food, which costs 990 billion dollars per year.<sup>8</sup> Food waste also contributes 3.3 billion tonnes of greenhouse gases annually—accounting for approximately 8% of global greenhouse gas (GHG) emissions.<sup>9</sup> It is a normal practice for many producers and distributors to incorporate food waste into their costs of production. For middle- and higher-class consumers, concerns about having consistent and reliable access to safe and affordable food are minimal, reducing the need to prioritize food-saving behaviours. The result is overproduction of food and excessive food waste—much of which is avoidable.

The problem of food waste isn't just discarded food products; the materials used to serve, separate, preserve, distribute, and store food also end up as "food-related waste." Food packaging and other single-use items—such as grocery bags, disposable cups, plates, and cutlery—fulfill consumer needs in terms of food safety, shelf-life, and convenience. Yet, these often come at a significant societal cost, particularly to the environment. Due to their size and composition, these items are rarely recycled and end up in landfills, where they can take an extremely long time to decompose. Acknowledging the impact

of food and food-related waste, the connection between these sustainability problems, and the way that they meet consumer needs will be an important part of developing a more sustainable food system for the future.

The goal of this report is to introduce readers—from consumers to policymakers—to food and food-related waste challenges in the Canadian food system.

## Food Waste

Research conducted by Second Harvest and Value Chain Management International reports that 35.5 million metric tonnes of food are lost or wasted annually in Canada.<sup>1</sup> This accounts for 58% of the total food produced in Canada—an estimated value of close to 50 billion dollars.<sup>9</sup> Recent reports suggest that Canada wastes significantly more food than the rest of the world; global food waste is estimated to be about 33% of food produced for human consumption.<sup>5</sup> Approximately one-third of the food Canadians waste is considered “avoidable food waste.” Some examples of avoidable and unavoidable food waste are provided in [Table 1](#).<sup>1</sup>

It is important to recognize that waste occurs across the supply chain, from the farm where raw materials are produced, to the foodservice/retail venues where food products are sold, to the consumer. Each actor in this chain has a role to play. For example, the Second Harvest report noted that in 2019, 21% of avoidable and potentially edible food waste occurs directly at the consumer level.<sup>1</sup> Due to the variety of methods used to estimate food waste, the exact numbers at each stage can vary significantly.<sup>6</sup> Importantly, there are opportunities for improvement at all levels—including at the consumer level.

In a world challenged to feed approximately 9.7 billion by 2050, tackling food waste presents a significant opportunity to improve our current food system. In addition to being inefficient, food waste creates pollution and diverts resources away from other activities. The time, land, water, energy, and other resources used to manage food waste (from farm to disposal) could be reallocated for other industries or preserved for future needs. Food waste also uses valuable space in landfills and puts added strain on our already overstretched waste management systems. Food waste has an impact from production to disposal and its reduction is a requirement for a more sustainable system in Canada.

## **Food-Related Waste**

In Canada, food packaging makes up about one-third of household food waste—3.4 million tonnes of waste each year.<sup>10,11</sup> At best, only 20% of these products are reused or recycled; the remaining 80% end up as litter or in landfills. Packaging produced with mixed materials, package sizes and shapes, and any residue from food or other materials make sorting and disposal of food-related waste a challenge for our waste management systems.

Yet, packaging is only one part of the problem. A significant amount of food-related waste also comes from food consumption, such as the utensils, cups, straws, and napkins that are thrown out after a single use. Occasional eating arrangements also contribute to food-related waste; events and meetings often use single-use plates, cutlery, cups, water bottles, and other containers to distribute food. Venues for such occasions rarely have proper recycling disposal bins, meaning that single-use products often end up in the trash. People are increasingly “on the go,” so they often look for “take away” food solutions; our food system has evolved to serve this market of convenience at the cost of increasing food-related waste. Problems with food-related waste will require solutions that acknowledge the role these materials play and how they fit with current consumer preferences in our food system.



TABLE 1

**Examples of avoidable, theoretical avoidable and unavoidable food waste.**

| Group                   | Prime condition   | Useable   | Inedible   |
|-------------------------|---|---|--|
| Avoidable               | <ul style="list-style-type: none"> <li>Unharvested fruit and vegetables</li> <li>Food not donated due to vendor agreement</li> </ul>  | <ul style="list-style-type: none"> <li>Vegetable stalks (e.g., broccoli) or fruit peels (e.g., orange peel)</li> <li>Products thrown away early due to misinterpretation of “best before” date</li> </ul>     | <ul style="list-style-type: none"> <li>Fruit left to spoil</li> <li>Crops/foods incorrectly stored</li> </ul>                    |
| Theoretically avoidable | <ul style="list-style-type: none"> <li>Undersized crop left in the field</li> <li>Edible fish species caught in by-catch, though not kept, as currently not marketed</li> </ul> | <ul style="list-style-type: none"> <li>Lobster shells disposed of at sea or buried instead of processed into food ingredients</li> <li>Foods served, though not eaten, due to portion serving size</li> </ul> | <ul style="list-style-type: none"> <li>Inventory that spoils due to lack or poor stock rotation policies<sup>68</sup></li> </ul> |
| Unavoidable             | <ul style="list-style-type: none"> <li>Husks, bran, and germ lost during the milling process</li> </ul>   | <ul style="list-style-type: none"> <li>Husks, shells, peels that can be processed into food ingredients</li> </ul>  | <ul style="list-style-type: none"> <li>Animal bones disposed of during HRI and at-home preparation of food</li> </ul>            |

# GAPS AND OPPORTUNITIES

## What Causes Food and Food-Related Waste?

Food and food-related waste are a direct result of the inherent perishability of these products and the current organization of the Canadian food supply chain. Although this chain is constantly evolving, the current system relies on food that comes from all over the world. What's more, our system aims to provide consumers with global food products that are low-cost, convenient, safe, and consistent. For the past 70 years, this consumer demand has shaped the food supply chain from the farm to retail. Only recently are consumers becoming aware of the impact of this demand. The utility of food has moved beyond subsistence as consumers recognize the links between food and health and look for food that is produced and processed in ways that provide additional value. This might include enhanced nutrition and/or taste, reduced environmental impact, or alternative production practices like organic, or "raised without antibiotics." While the demand for these types of products has increased, consumer interest in food and food-related waste has yet to transition into permanent market solutions.

## Gaps

To understand why there is so much food and food-related waste, and what can be done at the consumer level, we need to understand the behaviour that causes this waste. Since 2019, Arrell Food Institute hosted several multidisciplinary stakeholder meetings to discuss these issues. During these meetings, several behaviours, societal norms, and perceptions were identified as primary drivers of food and food-related waste at the consumer level.

### ***Attitudes Toward Food Waste are Ambivalent***

Generally, people don't want to waste food, but either view the impact of food waste as minor, or simply don't understand its full impact. Several factors influence this attitude. Cost is one factor; without externalities like the environmental impact of production and waste reflected in the price, food can seem cheaper than it really is and easier to justify throwing away. In 2011,

more than 80% of Canadians were living in urban centres. Urban consumers are far removed from where and how their food is produced and often have a limited understanding of the resources required to produce it. For many consumers, the impact of food waste is simply the disposal of unused food. Since food is compostable, many view food waste as having very little environmental impact. The misconception that food waste carries limited economic and environmental impacts may keep consumers ambivalent about this issue.

### ***Household Food Norms and Relationships with Food Have Changed***

Collectively, individual ambivalence about food waste has led to societal norms that accept food waste as “normal”. In the past, food was a significant household expense and food scarcity meant that people either ate the food that they had or found a way to preserve it. For economic and health reasons, food waste was simply unacceptable. Today, consistent access to affordable food has eliminated many traditional food-saving practices. The perceived cost of wasting food has diminished and prior expectations for children within a household like “finishing your plate” or “eating what is prepared for you” are no longer the norm. Shaping positive behaviour in children around food waste can play an important role in shifting future societal norms and expectations for others, while also teaching children to value food, rather than haphazardly waste it.

Previously, eating and cooking were well integrated into people’s daily routines. Meals were centred around groups and families, not just sustenance. In today’s “busy” society, there is less household food preparation. In some cases, personal relationships with those who make and prepare our food have diminished.<sup>12</sup> The appreciation that comes from knowing what goes into making our food (either growing or preparing and having a relationship with that person might make people less likely to waste food.<sup>13</sup> This connection to food has shifted, in part, at the cost of convenience. Further, food waste is generally quite private—our neighbours, friends, and family don’t necessarily see the amount of food we dispose of.

### ***Food Waste is Within Our Control***

Food purchasing decisions, storage, available food products, food literacy, and household food management all impact how much control individuals feel they have over their food waste decisions. More and more Canadian families have both partners working rather than having one stay at home. Traditionally, a stay-at-home partner would have been the one who purchased groceries, prepared meals, and cleaned up afterwards. Because these were their primary responsibilities, there was more preplanning, checking food inventories, buying the right amount of food, and then using up the food that was purchased.<sup>14,15</sup>

Changing family lifestyles have led us to move away from these habits. Larger fridges and improved storage options also help us keep larger volumes of food fresh, longer. This leads many consumers to buy more food than they need at any



## What Do Those Labels Mean Anyway?<sup>18,19</sup>

“Best-before” or “best-by” dates indicate when a product will no longer be at peak freshness or of highest quality. Normally, they are NOT an indicator of food safety; rather, they are a measure of food quality. These foods are typically safe to eat beyond the “best-by” dates.

Expiration dates, in Canada, are applied only to selected products such as infant formula. Worldwide “use by” dates labels are often present in perishable products and indicate when a product *may* no longer be safe to eat. Food should not be bought or sold after its use-by date.

one time. The popularity and potential cost savings of bulk purchasing (think of a family pack or bulk-buy food options) also present increased food waste challenges. Although possible, household “food management” is often more challenging today. People often buy too much, they don’t know what food they have, and it becomes difficult to plan meals that use up the food that they have purchased.<sup>16,17</sup> Busy schedules and household members on the go may also reduce the motivation to prepare meals at home. Ultimately, the result is generally more food waste.

Additionally, food waste might be regarded as an unavoidable price of a more wholesome diet and our quest for our long-term well being. Fresh healthier foods are often highly perishable, e.g., fruits and vegetables, and as a result, they tend to have a shorter shelf life, are less convenient, and are more likely to end up as food waste. Integrating meal planning and re-purposing food items can result in healthier diets without increasing food waste.

### ***Labeling Impacts Our Behaviours***

There is also insufficient information and a real misunderstanding among consumers about food perishability and open-dating food labels. The primary challenge has been the inability to differentiate between labels (e.g., “use-by” vs. “best-by” dates) and consequently misinterpretation of “best before” dates. Many people assume (incorrectly) that best-by labels are a direct measure of food safety, rather than food quality. Assuming proper storage, many products, such as cereal-based products (e.g., pasta, cookies), are safe to eat beyond the date stamped on their packaging. Consumers need to understand these differences to effectively respond to labelling queues, which adds to another limitation in people’s perceived ability to reduce food waste: time. Fortunately, campaigns to simplify labels and strategies to better communicate the state of a food at the time of consumption (e.g., labels that change color to denote spoilage) are gaining popularity.

### ***Having Control Over Food-related Waste Isn’t Always Easy***

If asked directly, consumers want to reduce their footprint and would say that they are not in favour of food-related waste. The perceived environmental impact of food-related waste products is very high as we see more and more news stories that showcase marine animals harmed by plastic items and shorelines polluted with trash. A study from Dalhousie University found that over 90% of Canadians believe plastic packaging is an issue and want the issue resolved.<sup>69</sup> Based on this information, consumer attitude doesn’t appear to be a limiting factor for reducing food-related waste.

In most cases, people generate food-related waste because packaged products or single-use food serving materials are the only options available to them.<sup>20,21</sup> This is primarily due to technological challenges to increase food access, extend shelf life, maintain safety standards at the same price and convenience without relying

on the use of plastic packaging.<sup>22</sup> Also, as previously discussed, people frequently eat on-the-go. Whether it be coffee in the morning or a salad at lunch, customers at fast-food restaurants might not be given the option to receive their food in reusable containers. The same is true for events or meetings. Organizers rarely have the infrastructure or capacity to buy, collect, wash, and store reusable containers; single-use products provide a convenient way for them to feed their guests.

From a consumer perspective, this limits their ability to reduce the amount of food-related waste that they generate. From the supplier perspective, there are few viable alternatives that can be used to provide food for the “on-the-go” lifestyle. Similar to food waste, time constraints also increase food-related waste in the household. People eat at home less and don’t have time for household “food management” or preparation.<sup>23,24</sup> This means that food needs to last longer and be effectively transported so plastic packaging is often the solution, although it ends up as waste. Overcoming people’s dependence on products that become food-related waste will be an essential part of reducing this problem. This might take the form of reducing packaging (e.g., over-packaging), eliminating the need for a product altogether (straws, for example) or finding less harmful alternatives (reusable and fully compostable containers and utensils).

### ***Individual Attitudes Shape Social Norms***

Social norms are shifting to accommodate consumer concerns about food-related waste. Restaurants and grocers are beginning to offer their customers different options for reducing waste. Take-out and left-over containers are increasingly shifting to more sustainable alternatives. Many fast-food restaurants now provide paper straws as an eco-friendly alternative to plastic straws, while some bars and restaurants have eliminated them altogether. Loblaw is collaborating with Loop Industries to provide their customers with products in reusable containers and then return them to the store to be washed and recycled for future use.<sup>25,26</sup> Similarly, online zero-waste grocery stores, such as Zerocery, have emerged as a sustainable alternative to supermarket grocery shopping. To further catalyze action in reducing food related waste, the Canadian government has proposed a ban on the use of single-use plastics, beginning in 2021. These changes have emerged as a result of social pressure to reduce food-related waste, lessons learnt from other countries and the continuous push to eliminate plastics and single-use products out of the Canadian food system.<sup>27-30</sup>

## Opportunities

Despite the many challenges that make it difficult to eliminate food and food-related waste, opportunities do exist.

### ***Changing Consumer Mindset Through Incentives and Disincentives***

Cost and, to a lesser extent, environmental impact have been identified as the two factors that impact attitudes about food waste.<sup>31</sup> While increasing the cost of food might be effective, this would be difficult to implement and would disproportionately impact those of lower socioeconomic status. Another option would be to increase the cost associated with food waste. This could be achieved by increasing the cost of green bins and food waste removal. However, as people look to avoid this cost, we would likely see more food waste ending up as litter or in garbage bins. Canada's waste management systems are already overstretched, and the negative impact of improper disposal would likely outweigh any benefits from reduced food waste. Furthermore, at ~\$1,000 a year, the household cost of food waste is already quite high.

This underlines the complexity of changing consumer mindsets through the most obvious financial pathways and therefore suggests that we must look at other ways to get consumers to prioritize reducing food waste. Some recommend engraining the economic costs of food waste into societal norms as an impactful way to change consumer mindsets.<sup>32</sup> Knowledge mobilization and communication on the existing household costs of food waste are the first step in this process, followed by tangible actions for households to easily integrate their food shopping with planning, preparation and storage routines.

### ***Raising Awareness—Educate—Repeat***

Simply telling consumers about the costs of food waste might be more effective than increasing prices.<sup>33</sup> We can communicate the costs of about food waste and its significant environmental impact, as well as link it to the land and water used when producing food and its greenhouse gas emissions to individual products. Food companies such as Quorn are explicitly informing consumers about the amount of greenhouse gases associated with each of its food item's production and manufacturing processes.<sup>34</sup> This conveys that wasting food is not just wasting nutrients, but also the energy and resources involved in the production, manufacturing, and distribution of each item. Similarly, carbon labelling has been developed, in part, in response to consumers' demands for information and advice on how to reduce their environmental footprints through their consumption behaviour.

Estimates suggest that food waste is responsible for approximately 2% of energy consumption in the U.S.<sup>35</sup> By informing consumers about the relative energy impact of food waste compared to activities like driving a car or heating an

apartment, we can better communicate the resources required to produce food. For example, comparing the amount of energy wasted by letting romaine lettuce spoil to the energy wasted from leaving windows open when the heat is on. The latter is a habit that most Canadian households would perceive as a massive waste of energy and money, making energy wasted due to food waste more apparent. To enable consumers to act on this information, such comparisons must be coupled with suggestions for action (see page 23 for suggested actions).

Civil society and government-led knowledge mobilization campaigns in grocery stores and restaurants about food waste would serve as useful nudges for consumers to think about their food waste. For example, the Love Food Hate Waste campaign in Canada encourages households to plan meals and provides tips to prevent food quality losses before consumption.<sup>36</sup> Offering simple messages, such as “meal planning means less food waste” can also help to raise awareness. Consumers could also benefit from understanding that the impact of wasting food differs depending on the type of food wasted and the resources involved in their production. For example, a steak, compared to an apple, demands more natural resources to produce and is also more detrimental to someone’s environmental footprint.<sup>37</sup> These details are widely reported in research forums, but do not often reach the general public. Better science communication could aid in bridging the gap between science and public understanding of food waste.

As a more long-term solution, this information could also be included in youth education curriculum through existing outreach programs such as AgScape, which brings lessons about farming and food to Ontario classrooms. This will allow the information to diffuse into households and create a lasting impact on future generations’ understanding of and care for food waste. Creating awareness about the environmental impact of food waste and inefficiency of composting to fully recover the resources invested in food production can also reduce food waste. Shifting social norms in composting is necessary to curtail overall household food waste and protect already overstretched waste management systems. Environmentally destructive behaviour has become socially unacceptable and bringing food waste into this discussion will create more pressure for people to reduce waste. A growing number of leading agri-food companies such as Maple Leaf Foods have set carbon neutrality targets and report on their corporate social responsibility in response to consumer and investor demands.<sup>38</sup> Reducing food waste is an important part of reaching such targets. Reducing food waste along supply chains reflects the reality that environmentally unsustainable businesses are not resilient to increasing and intensifying disruptions. Drawing these comparisons will help to challenge people’s own identity; people don’t want to think of themselves as harming the environment.

### ***Make Food and Food-Related Waste Prevention a Household Norm***

Another way to challenge current household food norms is to make food and food-related waste more visible. The Guelph Food Waste Audit Project conducted household audits in an effort to uncover and compare the amount of household waste produced.<sup>39</sup> Collecting food waste information can help increase awareness on the extent of waste produced and set goals and targets for reduction.<sup>40</sup> Utility providers may be able to gather data on household waste and compare this with regional averages, although this can be challenging with current waste management systems. Once this comparative data is readily available, people may be more likely to collectively work towards a target or strive to lower their household waste levels, if they trend higher than average. This approach can be a fun way for families and neighbourhoods to track food waste and find new ways to reduce it. This kind of citizen engagement initiative has been implemented in the Orange Bag program, where households participate in pilot projects that request them to separate their recyclable plastics from non-recyclable plastics. This program helps households better understand which plastics can be recycled and encourage reductions in consumption of plastics that are not easily recycled or reused, such as single use utensils.<sup>41</sup>

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## **THE GUELPH FOOD WASTE AUDIT PROJECT**

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**When:** 2014 — Present

**Why:** To understand why we waste food at home.

**Results:**

1. The average household's weekly food waste was 4.5kg.
2. 64% of all food waste was avoidable or potentially avoidable.
3. 50% of avoidable food waste was fresh fruits and vegetables.

**Implications:**

More conversations and education about food waste can help waste at the household level. [www.guelphfoodwaste.com](http://www.guelphfoodwaste.com)

### ***Changing Policy and Regulations***

Changing consumer behaviour is only part of the solution to address food and food-related waste. Coupling efforts to steer consumer behaviour with regulatory initiatives is likely to have a meaningful impact on mitigating food waste and plastic pollution. One highly impactful change would be regulating the consistency, simplicity, and clarity of food labels. While “use-by” and “best-before” dates can provide helpful information about food safety and quality, the meaning of these dates needs to be clearer, so consumers understand when food is unsafe to eat.



Local and global differences in wording on labels also leads to confusion among retailers and consumers. International food companies, such as Kellogg and Nestle, are responding to the demand for accessible food labels by committing to simplifying labels to reduce food waste.<sup>42</sup> Similarly, federal agencies are updating regulations geared to simplify expiration labels.<sup>43,44</sup> Regarding food related waste, countries like Australia and India are changing their policy approach to plastic pollution. In addition to bans on some single-use plastics, these countries have also invoked policies on manufacturers of plastics that require them to clean-up and recycle their products or include mandatory % or recycled material in the product.<sup>45</sup> Of course, these changes require significant discussion, negotiation, and collaboration at the national and global level to attain uniformity in labeling and waste management approaches and requirements.

#### ***Innovations to Reduce Food Waste***

Many innovations are being currently advanced and implemented to reduce food waste and improve waste management systems by diverse actors, from government to industry to individual consumers. Sensing devices that report on the freshness of food in real time and wireless sensor networks that collect information throughout the supply chain are innovations that will optimize food distribution. These devices will empower the retailer to reduce food waste and provide incentives to optimize food rotation. For example, the use of sensors, wireless networks, and quality control logistics can redirect peaches from Niagara that begin to ripen faster than anticipated to a grocer close to their production site, avoiding food losses during distribution.<sup>46</sup> Dynamic pricing based on sensor quality data allows providing discounts for products approaching their end of shelf-life.<sup>47</sup>

Governments can also play a leading role in catalyzing the development and use of new technologies. For example, Agriculture and Agri-Food Canada has launched the Food Waste Reduction Challenge.<sup>48</sup> This challenge will support innovations and technology development in the agri-food sector that show potential to scale and accelerate food waste reduction solutions.

#### ***More Research to Understand What Drives Food Waste***

While these recommendations are broad in nature, conducting more research on food waste can help target specific efforts and innovations that will have the biggest impact. This might include more food audits to identify foods that are commonly thrown out and tailored interventions based on the results. Since 2014, Drs. Kate Parizeau, Mike von Massow, and Ralph Martin at the University of Guelph have been doing just that. By sorting through and studying what ends up in Guelph residents' compost bins, they hope to better understand what gets wasted, who wastes it, and why it ends up there.<sup>49</sup> This research program considers a diversity of factors that influence food wasting behaviours at the household level to inform waste management systems and policies to reduce food waste.

***Acknowledge and Support Solutions that Don't Directly Involve Consumers***

While this paper is focused on consumers, it is imperative to explore solutions to the waste problem at all levels—primary production (e.g., farms), processing, distribution, retail, food service. We must also start thinking about these systems through the lens of the circular economy. That is, to shift our perspective on food production and consumption and begin looking for new opportunities to make use of every product, component, and material that goes into, and comes from, food production.<sup>50</sup> In other words, we must look for alternative and/or secondary uses for everything that goes into our food system; in doing so, we will ensure we always get the highest value.

# WHAT DO WE DO WITH ALL OF THOSE COFFEE GROUNDS?

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Large-scale production of food often results in large volumes of wasted food or by-products. Instead of disposing them, these waste or by-products can be repurposed as sources of materials and ingredients. Global consumption of coffee in late 2019 and early 2020 was approximately 10 billion kilograms; that's a lot of spent coffee grounds!<sup>49</sup> Applying “circular thinking” means we don't just dispose of these grounds, rather, we look for secondary uses. The Sustainability Office at the University of Guelph has launched a program run by volunteers to collect coffee grounds on campus and compost them for use at the university's Urban Organic Farm. In addition to local initiatives, researchers across the world are exploring new opportunities to use this by-product, in the production of bioplastics, organic fertilizers, renewable energy, drinks (infusions and beers), and other consumable goods. For example, the University of Guelph's Bioproducts Discovery and Development Centre (BDDC) has designed and implemented sustainable materials for the headlights in the 2020 Ford Lincoln vehicle using coffee waste from McDonald's roasting facilities.<sup>51</sup>

Consumers certainly have their role to play in curbing waste but, clearly, the size, scale, and resource capacity that comes with industrial food production create opportunities to effectively repurpose large volumes of food waste through innovative agri-food product development.

***Continue to Support the Mindset on Food-related Waste and the Industry Shift***

Food-related waste and food packaging go hand-in-hand along agri-food supply chains. We experience this at the consumer level: when we finish an on-the-go meal, we often resort to throwing the uneaten items in the garbage along with their container. Unlike food waste, reducing food-related waste depends heavily on consumer attitudes towards alternatives for utensils and food packaging materials. This might include reusable products or other single-use products that have less environmental impact. Increased education that promotes the benefits of these products would help make consumers feel better about using them, increase adoption, and reduce the demand for current, more harmful products.

The market is already responding to consumer interest in reducing food-related waste and new products and programs are currently being put in place. For example, in 2019, Unilever announced that by 2025 it will halve its use of virgin plastics and reduce all plastic packaging by more than one hundred thousand tons.<sup>52</sup> Alternatives to conventional plastics, such as biodegradable and recyclable bioplastics, are being developed amid growing consumer demand.<sup>53</sup> A metrics approach, such as waste benchmarking, enables the industry to set targets that everyone in their supply chain can understand and contribute to. This highlights the significant role that processors and retailers play in leading waste reduction strategies throughout the food supply chain. Increasingly, processors and retailers are setting waste reduction targets that drive the sector towards a circular economy and create multiple co-benefits to waste reduction. For example, Loblaw's Inc. aims to reduce their food waste by 50% by 2025, using 2016 as their benchmark year. This initiative includes redirecting food such as stale bakery products that are normally disposed to local farms for animal feed.<sup>54</sup>

Although plastic bags are just one example, it highlights the need to develop solutions for reducing a behaviour that increases food-related waste (using plastic packaging and grocery bags). Similar scenarios can be created for a number of products that end up as food-related waste. Caterers or restaurants that provide food for meetings could provide reusable dinnerware at an additional cost. Fast-food restaurants concerned about insufficient packaging could create a reduced packaging option and assess consumer preference. Additional research from psychology, economics, and marketing should complement this work to create effective, long-term strategies for achieving the desired behavioural outcomes for food and food-related waste.

# FIVE CENTS A BAG

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The negative environmental and social impacts from the abundance and persistence of single-use plastics in landfills and leaked into the environment have caused a global movement to reduce plastic pollution. Governments worldwide have been responsive to this call to action, with over 127 countries regulating single-use plastics. One common regulation that many countries have implemented is a ban on single-use plastic bags by retailers, which is especially observed in grocery stores.

In response to governmental plastic bag regulations and taxes, grocery stores began to charge customers \$0.05–\$0.10 per plastic bag. In many cases, this rapidly shifted consumer behaviours. In 2002 in Ireland a compulsory tax was added on plastic bags, which resulted in over a 90% decrease in the number of plastic bags issued.<sup>55</sup> At such small fees, you would think that the convenience of plastic bags would be worth the price. The cost of plastic bags at the check-out plays only a limited role in the behavioral change. Interactions with retail employees for the purchase of single-use plastic bags has shown to nudge consumers towards adopting an expected behavior (i.e., bringing reusable bags).<sup>56</sup>

Public calls to action and regulations on plastics has also fueled research and development for biodegradable bioplastics, which some suggest can reduce our reliance on fossil fuels while reducing the amount of plastic waste. Although such alternatives and others like paper bags may at first appear to be a sustainable solution, it is important to assess their life cycle and associated environmental impacts. It is also equally important to understand the impacts of regulations on society and whether they will disproportionality affect or even marginalize different groups. Plastic bans and taxes reduce the availability of products that the foodservice industry can utilize and impact how they manage, absorb, or pass on the cost of changing from single-use plastics to alternatives. Researchers are increasingly taking systems and interdisciplinary approaches to problems such as plastic pollution to uncover solutions and policy approaches that limit unintended negative consequences and externalities.<sup>57</sup>

# KNOWLEDGE SHARING AND POLICY FOR IMPACT

Numerous opportunities exist for reducing food and food-related waste and many communities across the country are already implementing these. While it is beyond the scope of this report to explore every detail of food and food-related waste, the examples presented in this report can be used for further analysis and development of solutions.

## ***“Better” Alternatives to Single-Use Products and Plastic Packaging?***

Consumers are increasingly in favour of reducing plastic packaging and single-use products. A survey recently conducted in England found that 82% of interviewees were actively trying to reduce the amount of plastic they utilized.<sup>61</sup> Despite consumer’s good intentions, the cucumber example on page 22 shows us that eliminating packaging isn’t always the best solution. So, are there alternatives to plastic that are better for the environment? This is difficult to answer, as measuring the environmental impacts of a behaviour or product can be challenging. Even comparing the environmental impact of different alternatives to single-use plastic grocery bags is a complex issue.<sup>62-66</sup>

Life cycle assessments are commonly used to measure these products’ environmental impact (e.g., CO<sub>2</sub> emissions, land use, water use, fossil fuel use, waste produced) from creation to disposal. These assessments provide a method for evaluating the environmental impact of products and often debunk popular assumptions about products that tend to focus on only one part of the life cycle (e.g. disposal). For example, single-use paper bags are often advertised as a more environmentally friendly or “natural” alternative to plastic bags for groceries. However, research has shown that paper bags were actually worse for the environment for each measure in the assessment and that it takes three uses of a paper bag to equal one single-use plastic bag’s environmental impact.<sup>67</sup> Oftentimes the results of such studies are not clear, as some products performed better only for certain measures (e.g., just CO<sub>2</sub> emissions). These studies do not include the cost of plastic removal from the environment or the pervasive and persistent effects of plastic waste on the ecosystems (such as microplastics). This makes it difficult for consumers to evaluate whether alternatives to plastic products are actually better. Creating clear priorities for specific measures of environmental impact will be needed to guide meaningful change in the products that we use and dispose.

Although it is beyond the scope of this report to discuss in detail, there are also significant opportunities for improving the management of food and food-related waste. In Canada, waste *management* systems are overseen at the municipal level, creating regional differences in the type of management that can be done and differences in what is required by the industry and the consumers. This lack of consistency makes it difficult for consumers to know what to do with their waste and creates a disconnect between market efforts to reduce waste and the capacity of processing plants to handle these products.

An example that highlights the problems in our food and food-related waste management systems is single-use coffee pods. Pods were developed as a convenient and affordable alternative to brewing a whole pot or buying coffee from restaurants. However, the pod's design meant that a significant amount of packaging material and coffee grinds were ending up in landfills. To address this problem, several companies developed certified compostable pods. However, the requirements for these products to break down require industrial composting conditions that are often beyond the current capabilities of Canadian waste management facilities. As a result, coffee pods end up in municipal compost bins and become a contaminant in the final composted product, reducing its quality. Consumers see the term compostable on the label and are unable to distinguish whether their local waste management systems can process this product or not. Similar experiences can be described for recycling. Depending on the product and location, we see differences in the materials that can be recycled, whether they need to be sorted and whether they need to be cleaned. Following a similar approach to reducing food and food-related waste, solutions must consider the current infrastructure limitations and the potential outcomes of unintended consumer behaviour that can lead to improper food and food-related waste management. Investment in end-of-use facilities would greatly improve management of waste to put resources back to use (materials, compost or energy) instead of the landfill.

# THE PLASTIC-WRAPPED CUCUMBER

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A major challenge in reducing food-related waste is the role it plays in reducing food waste. For example, a cucumber wrapped in plastic is estimated to last up to 15 days, while an unwrapped cucumber will begin to lose moisture and firmness within three to seven days of storage.<sup>58,59</sup> Extending a product's shelf life by using appropriate packaging increases the likelihood that a product will be consumed and not disposed of as waste; however, this adds to the waste problem.

Without packaging, rapid onset of moisture loss, discoloration and reduced firmness can make cucumbers less appealing to eat than those protected by plastic wraps. The benefits of plastic are also seen further back in the supply chain. Plastic is water-resistant, cheap, and lightweight. This makes it ideal for protecting foods, reducing supplier costs, and reducing food losses during food transportation from processors to retailers.

Although plastic packaging may be perceived as the lesser of two evils in reducing the impact of waste in our food system for now, alternatives that can contribute to further reduce both food and food-related waste at the same time continue to be explored. For example, compostable plastic shrink wrap used by Nature Fresh has the potential to improve the freshness of fruits and vegetables while also mitigating plastic pollution, provided that local waste management systems can process them.<sup>60</sup>



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# TAKING ACTION FOR FOOD WASTE

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Action on food and food-related waste will need to involve increased coordination between a number of actors. There are a variety of ways each group can work to take action for food waste, some of which are highlighted below.

| Group                    | Action Item   |
|--------------------------|---|
| Consumers                | <ul style="list-style-type: none"><li>• Use meal planning to reduce over-buying and generating waste (food and packaging)</li><li>• Store food appropriately and according to suppliers' recommendations</li><li>• Understand the meaning of open-date labels</li><li>• Be strategic on where you store food and leftovers (e.g., fridge vs. freezer) based on when you plan to eat them</li><li>• Rework leftovers into new meals</li><li>• Prioritize the use of leftovers over preparing new dishes</li><li>• Participate in local programs that manage waste and food-related waste</li><li>• Use apps that help you cut food waste</li></ul> |
| Caregivers and Educators | <ul style="list-style-type: none"><li>• Prompt reflection on food purchasing, storage and consumption current practices</li><li>• Integrate food literacy and food waste education into the curriculum</li><li>• Teach youth about the impact of food waste (e.g., waste of resources to produce food and climate change implications)</li><li>• Make reducing food waste fun by creating rewards for reductions in waste levels at the household and schools</li></ul>   |

| Group  | Action Item  |
|--|--|
| <b>Food Processors and Marketers</b>             | <ul style="list-style-type: none"> <li>• Align branding with food waste reduction targets</li> <li>• Commit to introducing novel tools to better communicate expiration dates, remaining shelf-life, and recommended storage conditions</li> <li>• Minimize the use of packaging and select packaging materials and designs, taking into account disposal and sustainability</li> </ul>  |
| <b>Food Retailers and Food Service Operators</b> | <ul style="list-style-type: none"> <li>• Implement and optimize systems to keep track of purchasing, inventory and prepared meals</li> <li>• Closely monitor storage and distribution conditions</li> <li>• Implement incentives for the customer to purchase older but still safe products (e.g., dynamic pricing)</li> <li>• Increase flexibility in terms of portion sizes and production volumes to better match consumer demands</li> <li>• Request feedback from the customer on their needs for flatware, serving dishes, storage containers, and take-away containers</li> <li>• Adapt portion sizes and production volumes to better match consumer consumption</li> <li>• Prioritize food monitoring to early spot signs of spoilage and facilitate repurposing into meals (e.g., produce or day-old foods, so yesterday's bread becomes today's bread pudding)</li> </ul> |
| <b>Government and Academia</b>                   | <ul style="list-style-type: none"> <li>• Facilitate and fund innovative technologies and solution to food waste</li> <li>• Foster public-private-people partnerships on food waste knowledge mobilization, technology development, and research</li> <li>• Provide leadership and guidance on best practices in food waste reduction</li> <li>• Establish standards for food packaging that reduces food-related waste</li> <li>• Provide incentives for packaging that can be effectively managed at municipal level and diverted from landfill</li> <li>• Standardize the requirements for municipal processing facilities and support upgrade to modern processing standards.</li> </ul>  |

## — CONCLUSION

This report highlights some of the complexity surrounding food and food-related waste, with emphasis on the solutions and opportunities ahead. We have discussed the interwoven issues that stem from food and food-related waste, including their role in climate change and plastic pollution, while also sharing examples of innovation in food distribution technology, packaging, and initiatives. Reducing food and food-related waste will be essential to the long-term sustainability of our food systems. Encouraging and enabling consumers to adopt positive food waste behaviours and practices can collectively reduce food waste's negative impacts on households, communities, the environment and supply chains.

While this report has focused on consumer food waste, the onus of the food waste problem does not solely rest on individual consumers' shoulders. Farmers and food processors, manufacturers, distributors, retailers and marketers all have important roles in reducing food waste along the supply chain. Marketing targeted at food and food-related waste must continue to increase. Research and government must act to facilitate, foster and scale up the development of technologies and innovations that show promise in reducing food waste. These actions can vary from initiatives such as the Food Waste Challenge recently launched by Agriculture and Agri-Food Canada (AAFC) to the development of biodegradable plastics, labels and tracking systems. The diversity of stakeholders involved and possible solutions to food and food-related waste underlines that consumers are not acting alone. The challenge ahead is aligning all innovative food waste solutions to create societal practices, norms and behaviours that contribute to a low-waste society. Looking forward, this is achievable through concerted efforts of all the stakeholders to set ambitious food waste reduction targets and share best practices and approaches to ensure attaining such targets and embedding food waste reduction norms into communities.

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## Workshop Summary

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## Participants

Attendees of the two workshops, who helped form and edit the discussion paper, consisted of academics, technical experts, government, and industry. We wish to thank all participants for their insight: Pauline Cripps (Guelph Food Bank), Evan Fraser (U of Guelph), Daniel Gillis (U of Guelph), Kate Parizeau (U of Guelph), Jeff Farber (U of Guelph), Amar Mohanty (U of Guelph), Vivian de Giovanni (City of Guelph), Karyn Hogan (City of Guelph), Lawrence Goodridge (U of Guelph), Shoshannah Jacobs (U of Guelph), Cathy Kennedy (City of Guelph), Erica Pensini (U of Guelph), Brandon Raco (U of Guelph), Ashutosh Singh (U of Guelph), Barbara Swartzentruber (City of Guelph), Milka Popov (U of Guelph) and Mario Martinez (Aarhus Univ.).

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