AN ANALYSIS OF FOOD WASTE IN ONTARIO'S DOMESTIC FRESH STRAWBERRY SUPPLY CHAIN

Anne Siu

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Anne Siu   Dr. Rod MacRae
MES Candidate   Graduate Supervisor

<u>ABSTRACT</u>

Food waste is increasingly being characterized as a prominent global problem. Along with the significant environmental and financial impacts associated with food waste, perhaps more troubling is the phenomenon's global persistence in spite of worldwide hunger. Despite growing recognition of the issue, however, research on food waste has remained limited and effective reduction strategies have not been achieved.

This paper contributes to the development of a comprehensive body of food waste research, conducted as a case study on food waste within Ontario's domestic fresh strawberry supply chain for the years 2008 to 2012, inclusive. It presents quantitative and qualitative analyses of the occurrence and perceived causes of food waste, based on information-synthesis from a review of comparable food waste studies and surveys administered to supply chain actors. The recent removal of Ontario's grading standards also provides a unique opportunity to assess historical assumptions concerning government grading standards as key mediators of waste generation.

The results indicate that 56% of edible strawberries grown in Ontario, by volume, are wasted through the course of the supply chain. The percentage estimates of strawberries wasted at each stage are: 15% during agricultural production; 11% during post-harvest handling and distribution; 9% during retail; and 35% during consumption. From a comparative standpoint, consumers are most contributive to waste, while retailers are least. The causes of food waste have been categorized into several areas: biophysical factors, technical factors, issues of mismanagement, regulatory factors, behavioural factors, and the dynamics of supplier-retailer relationships. In particular, increasing import-reliance and the dominance of food retailers are each of significant influence. Incremental strategies for food waste reduction and prevention are here presented in terms of the efficiency-substitution-redesign (ESR) framework. Overall, strategies addressing food waste are considered to be part of a more general transformative movement towards a food system that is ecologically sustainable, health-oriented, and equitable.

FOREWORD

This Major Research Paper represents the culmination of my experiences in the Master of Environmental Studies program at York University. The exercise of researching and writing this paper, as well as the preceding coursework, field experiences, internships, and volunteer opportunities, have all contributed to the fulfillment of my goals outlined in my Plan of Study. My Plan of Study is centred on three inextricably linked Areas of Concentration: "Food surplus, food waste and sustainability"; "Urban food security"; and "Canadian food policy". Ineffective governance and an absence of a national joined-up food policy have tacitly permitted the problems of food waste and urban food insecurity to persist. At its core, this Major Paper explores the nature of food waste in Ontario's domestic fresh strawberry supply chain. The substantive knowledge gained in the process of researching and writing this paper primarily encompasses, above all, the learning objectives of my first area of concentration, "Food surplus, food waste and sustainability". By focusing on one particular case study, I was able to gain a more comprehensive and nuanced understanding of: the causes of food surplus and food waste within urban food systems; how food waste affects environmental, economic, and social sustainability; and various strategies aimed at reducing food waste. The research process for this paper was exhaustive, requiring countless hours of analyzing peer-reviewed articles, statistical datasets, industry reports, legislation, and more. As this was my first extensive exposure to collecting and organizing primary data, I feel that I have also gained valuable and applicable skills in researching and writing.

This paper's examination of food waste intersects with a wide range of disciplines, which assists me in achieving some of the learning objectives of my other two areas of concentration. In particular, a large portion of this research paper is dedicated to understanding the various impacts of government legislation, at all levels- how it shapes the structure of local food systems, how it contributes to waste generation, how it can induce effective changes, and more. Through this study's literature review and interactions with supply chain actors, I have also gained a better perspective on how certain actors have stronger influences on the development of food policies.

I decided to research food waste for this paper because food waste physically and symbolically represents the contradictions of the current food system. Food waste is both a symptom of and contributor to the dominant food system, which has allowed a small number of actors to dictate the structure and priorities of the food system, often at the expense of the environment, public health and individual livelihoods. On a personal level, it is no surprise to those who know me that I would choose food waste as my central topic. Growing up, wasting food in my household was simply not possible on a limited budget. The thought of so much food being wasted is frustrating, but it compels me to learn more about the issue in order to promote effective changes.

ACKNOWLEDGMENTS

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SECTION 1: INTRODUCTION

Within the last ten years, food waste has increasingly been characterized as a prominent global problem. All levels of governments, private businesses, and the general public have bolstered the call to take action on what is largely seen as an avoidable issue. The United Nations' Food and Agriculture Organization (FAO) estimates that one-third, or 1.3 billion tons, of the edible parts of food produced globally is lost or wasted each year (Gustavsson, Cederberg, Sonesson, van Otterdijk & Meybeck, 2011). Food is wasted in exorbitant amounts in industrialized countries; in Canada, a staggering 40% of the food that is produced is wasted, representing a lost value of $27 billion dollars annually (Gooch, Felfel & Marenick, 2010).

Food waste is associated with several negative financial and environmental impacts. It is costly when considering the loss of the potential value of food and the fees associated with its disposal. Additionally, when food is discarded, significant environmental resources necessary for the production, processing, distribution, and disposal of food are squandered (Miller, 2012). In the United States, the production of food that is wasted represents over 25% of the total freshwater used in the country and around 300 million barrels of oil (Gunders, 2012). In Ontario, over one-quarter of the province's waste stream is comprised of organic matter, with much of it disposed of in near-capacity landfills (MOECC, 2013). The disposal of food waste in landfills imposes additional environmental pressures from the release of harmful greenhouse gas emissions. For every tonne of landfilled food waste, 125 metric tonnes of methane gas and carbon dioxide are produced (Melikoglu, Lin, & Webb, 2013). The release of methane is particularly problematic as it is 25 times more damaging to the environment than carbon dioxide (Gooch et al., 2010). Potentially toxic leacheate can also leak from landfills into soil and groundwater threatening nearby biophysical environments (Griffin, Sobal & Lyson, 2009).

In addition to the significant environmental and financial impacts associated with food waste, what is more troubling, perhaps, is the phenomenon's global persistence, in spite of approximately 842 million people suffering from chronic hunger (FAO, 2013). The 2008 World Food Crisis exposed the vulnerability of the world's poor, with many unable to afford the rising prices of basic food staples (Holt-Giménez & Shattuck, 2011). Even in

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affluent countries like Canada, more than 1 in 10 households experience food insecurity (Tarasuk, Mitchell & Dachner, 2013). Pope Francis highlighted the moral wrongdoing of food waste when he famously declared in his weekly address that; "Throwing away food is like stealing from the table of the poor and the hungry" (McKenna, 2013). The challenge of feeding the world's hungry will only intensify as the global population grows. The FAO predicts the global population will reach 9.3 billion by 2050 and in order to meet future food needs, global food production must increase by 70% (FAO, 2009).

The call for increased food production reflects the dominant paradigm held by governments and businesses alike. However, the focus on intensifying agricultural productivity hides the fact that the world already produces enough food to meet current and future global food needs (Holt-Giménez, 2012). Agricultural production requires significant energy, water, and land resources and its intensification will only add further strain. For example, agricultural production accounts for 10% of the United State's total energy budget, 80% of consumptive water use, and more than half of all land use. It is also a major source of anthropogenic greenhouse gas emissions, with hundreds of millions of pounds of pesticides released into the environment every year (Gunders, 2012). Given this, reducing food waste can be part of a more sustainable approach for achieving global food security, requiring no additional production inputs (Hodges, Buzby & Bennett, 2011). It promotes environmental sustainability by conserving energy resources, protecting natural habitats, and preserving water and air quality (Griffin et al., 2009). Reducing food waste increases the availability of nutrients to individuals and with less than a quarter of the food wasted in the US and Europe alone, there is enough food to feed all of the world's hungry (Stuart, 2009).

While there is growing acknowledgment that the reduction of food waste is an important component for improving food security, research on food waste remains limited and significant knowledge gaps persist. Available food waste studies are fragmented, few in number, and face methodological challenges. This paper expands the current body of research by conducting a case study on food waste in Ontario's domestic fresh strawberry supply chain. It builds on previous work by Kohn (2011), who examined the generation of food waste in Ontario's supermarkets and its wider impacts on the food system. The overall objectives of this paper are to quantitatively and qualitatively explore the occurrence of

food waste within Ontario's domestic fresh strawberry supply chain. In doing so, this paper examines perceptions, from the standpoint of actors in the supply chain, regarding food waste—its causes, challenges, and opportunities. It will also question whether recent changes in provincial produce grading standards, historically a key contributor to waste, have had any noticeable effects on reducing or mitigating food waste. This analysis begins in Section 2 with a review of how food waste is defined and measured within the current body of food waste literature and briefly compares trends between industrialized and developing countries. Section 3 presents this study's methodological framework, including its guiding research questions and the analytical frameworks used to answer these questions. Section 4 examines the basic structure of Ontario's domestic fresh strawberry supply chain. This study presents its findings for the occurrence of food waste in the chain in Section 5, followed by the perceived causes for food waste in Section 6. Section 7 discusses noticeable trends in this study's findings, identifying opportunities for future food waste research. Section 8 synthesizes the opinions of this study's chain actors with conclusions from previous studies to recommend strategies for reducing food waste in the supply chain. This study closes with Section 9. This paper contributes to the development of a comprehensive body of food waste research, and in particular adds to the limited availability of Canadian studies. It is the hope that the findings of this research will inform future and complementary studies in the area.

SECTION 2: REVIEW OF FOOD WASTE LITERATURE

2.1 Food waste research remains limited

Research on food waste is expanding in response to renewed global interest; however, it remains partial. For the entire 1990s, fewer than 20 items containing the term "post-harvest losses" were published in Agricola, the world's largest agricultural electronic database. Similarly, only ten publications on post-harvest losses were found among the 5.8 million scientific publications available in the Web of Science (Smil, 2004). Fortunately, the number of food waste studies has steadily increased in response to growing global concern for the issue. Knowledge gaps continue to exist in part due to practical, confidentiality and politically motivated barriers that have limited the accuracy and accessibility of food waste

statistics and analyses. The majority of research is conducted within Western Europe and the United States; few studies analyze food waste within Canadian contexts. There is only a small number of peer-reviewed food waste studies in the USA and of the limited studies examining postharvest losses in the USA, none estimate total postharvest losses on-farm or during processing (Hodges et al., 2011). In Canada, food waste research primarily focuses on post-consumer waste treatment methods, while the quantification of food waste and relevant analysis on the causes of food waste are often overlooked. To date, only a handful of Canadian food waste quantification studies have been published. Gooch et al.'s (2010) study *Food Waste in Canada* is the most commonly referred to estimate of food waste within Canada's agri-food sector. A small number of food waste studies are conducted in Ontario, however, these studies are ad hoc and differ in scope. Forkes (2007) examines the nitrogen balance for the flow of food waste in Toronto to determine the impact of municipal waste management policies and programs. The Guelph Food Waste Project (GWFR) (2014), a partnership between the City of Guelph and the University of Guelph, is currently conducting waste audits in order to quantify and characterize food waste generated by Guelph households. Similarly, the regional municipality of York (2012) is currently conducting its own food waste audits of York Region households in its SM4RT Living Plan. As mentioned, Kohn's (2011) study on the generation of food waste in Ontario's supermarkets and its wider impacts on the food system is of particular relevance to this paper. Individual companies may also be conducting internal assessments of food waste in their operations; however, until this data is openly shared with researchers, food waste research in Canada and Ontario will remain partial.

2. 2. Defining food waste

A range of definitions for food waste is used within the research literature, each with their own underlying assumptions. The Food and Agriculture Organization (FAO) provided one of the earliest. Food waste is the, "…wholesome edible material intended for human consumption arising at any point in the food supply chain that is instead discarded, lost, degraded or consumed by pests" (Parfitt, Barthel & Macnaughton, 2010 citing FAO, 1981). Since then, food waste has been further defined and categorized to indicate where

food waste occurs along the food supply chain, whether it is edible or inedible, and its degree of avoidance. Figure 1 provides an overview of food waste categorizations.
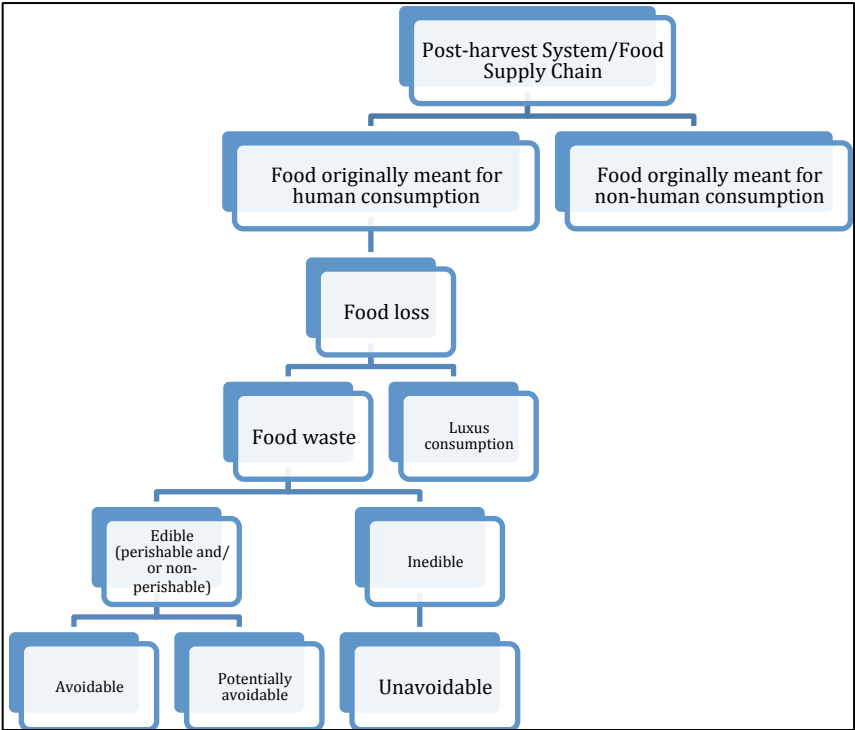
Figure 1: Overview of categorizations of food waste.
Adapted from: Parfitt et al., 2010; Hodges et al., 2011; Stuart, 2009; Smil, 2004; Gunders, 2012; Gustavsson et al., 2011; Quested & Parry, 2011; Terry, Mena, Williams, Jenney & Whitehead, 2011.

Within the literature, food waste is commonly defined according to where it occurs along a food supply chain. While the majority of studies consider food waste in relation to foods originally meant for human consumption, a handful of scholars include edible foods that are intentionally diverted for non-human uses, such as for animal feed and bioenergy. Debate continues on whether pre-harvest losses are in fact losses, considering that nutrients are returned back to the soil. Most studies choose to exclude pre-harvest losses and instead focus only on losses occurring after a crop is harvested (Gunders, 2012). A discussion on pre-harvest losses will be revisited later in this paper.

Considering a food supply chain as a whole, all of the measurable quantitative and qualitative food loss is usually referred to as post-harvest loss (Hodges et al., 2011). Subsequently, post-harvest loss is categorized into food loss and food waste. Food loss is generally defined as a decrease in quantity or quality of food mass throughout the part of

the supply chain that specifically leads to edible food for human consumption. Food loss characteristically occurs during the production, post-harvest and processing stages in the food supply chain (Parfitt et al., 2010). Slight differences exist within the literature on whether food loss refers only to the loss of edible food mass (Hodges et al., 2011), or both edible and inedible food mass (Gunders, 2012).

Food waste, on the other hand, refers to a subset of food loss that is potentially recoverable for human consumption (Hodges et al., 2011). Food waste occurs specifically at later stages in the food supply chain, primarily retail and final consumption (Parfitt et al., 2010). Studies conducted in industrialized countries may use the term food waste to refer to both food loss and food waste. This decision simplifies discussions and recognizes that industrialized countries characteristically have higher incidences of food waste occurring throughout the later stages of the food supply chain (Parfitt et al., 2010; Hodges et al., 2011).

Depending on the study, food waste is further categorized as edible or inedible; avoidable, possibly avoidable, or unavoidable; and perishable or non-perishable (Parfitt et al., 2010). Avoidable food waste is waste that is thrown away that was, at some point prior to disposal, edible; for example, slices of bread or meat. Possibly avoidable food waste is food and drink that some people eat and others do not, or that can be eaten when a food is prepared in one way but not in another. Examples of possibly avoidable food waste include bread crusts and potato skins. Unavoidable food waste arises from food and drink preparation and is not, and has not been, edible under normal circumstances. Meat bones, eggshells, and apple cores are examples of unavoidable food waste for humans but not other processes (Quested & Parry, 2011; Terry et al., 2011). Other studies (Smil, 2004; Garriguet, 2006; Blair & Sobal, 2006) identify another type of food waste that includes over-nutrition or luxus consumption. This form of overconsumption refers to the gap between the energy value of consumed food per capita and the energy value of food needed per capita. Whether through overconsumption or waste, the average Canadian consumes far more calories than is needed for good health (MacRae, Cuddeford, Young & Matsubuchi-Shaw, 2013). The occurrence of luxus consumption results in increased storage of body fat, health problems, and excess resource utilization (Blair & Sobal, 2006).

This paper adopts Gustavsson et al.'s (2011) interpretation and defines food waste as the mass or volume of food lost or wasted in the part of food chains generating edible products for human consumption. As such, food waste is measured only for foods that are directed to human consumption, excluding feed and parts of products, which are not edible. Subsequently, food originally meant for human consumption but leaves the human food chain is still considered a loss even if it is then directed to non-food use. This study also chooses to include pre-harvest losses in its analysis. Similar to other studies conducted in industrialized countries, the term food waste is used in this study to refer to both food loss and food waste occurring throughout the entire fresh strawberry supply chain in Ontario.

While this paper adopts a somewhat conventional understanding of food waste, it also recognizes that "food waste" as a concept, is socially constructed based on a particular set of assumptions. Among the research literature, few studies problematize these assumptions. Conventionally, waste consists of the final by-products and outputs occurring at the "end-of-pipe" in linear processes of production, consumption, and disposal. Waste is an innate property or characteristic of certain things; it is leftover, rejected and worthless (Evans, Campbell & Murcott, 2013). Similarly, the term "food loss" assumes a naturally occurring phenomenon arising in food systems in which little can be done to avoid it. In contrast, agroecological perspectives depart from conventional constructs and view "waste" as an essential asset. Rather than imagining waste as useless and occurring at the end of linear processes, valuable "waste" is an essential component within closed loop systems. Waste does not necessarily exist in closed loop systems as lost, unused, or leftover materials are reincorporated as agricultural inputs. Governments and private businesses regularly justify their interventions using conventional concepts of food loss and food waste (Smil, 2004). However, if the achievement of environmental sustainability is a central driver for food waste reduction approaches, the concepts of food loss and food waste must be critically examined.

2.3. Measuring food waste

Research is limited by the difficulty in conducting accurate assessments of food waste. The method of measuring the quantity of post-harvest loss is usually by weight, however, other units of measure include calorific value, quantification of greenhouse gas

impacts and lost inputs (Parfitt et al., 2010). In order to analyze food waste, researchers may choose to actually measure food loss, estimate food loss using questionnaires, or infer food loss rates based on existing data sets; each approach is subject to its own limitations (Hodges et al., 2011). First, researchers may choose to actually measure what has been lost, however, the quantity of food at the outset of a study must be known, which is rarely the case (*ibid*). Second, food waste can be estimated using questionnaires to determine subject loss estimates from those who have experienced them. Researchers have employed a range of methods to estimate food loss, including structured interviews, measurement of plate waste (Langely et al., 2009), and direct examination of garbage (Harrison, Rathje & Huges, 1975; Rathje & Murphy, 1992; Hodges et al., 2011). Third, researchers may utilize inferential approaches in which waste factors measured in sample populations are applied across the food system (ERS, 2014). Governmental bodies seeking national food loss data frequently use this method, including the Economic Research Service (ERS), the main source of economic information and research in the United States Department of Agriculture (USDA). This method is prone to inaccuracy as cumulative errors can occur if incorrect waste factors are applied in early stages of food system calculations (Hodges et al., 2011). In addition to the practical limitations noted above, food waste studies often rely on extrapolating information from limited data sets. These data sets are conducted at different times, in different regions, and may be based only on a specific part of a food supply chain or for a specific commodity (Parfitt et al., 2010). Differing interpretations of food waste among researchers, using a range of methodological approaches, give rise to inconsistent quantification values, which conflate estimates across countries and make identifying trends more challenging. Furthermore, industry data on food waste is often inaccessible to researchers; in the event of cooperation, information may be biased or incomplete. In addition to the practical methodological limitations noted above, political influences are also responsible for the lack of comprehensive food waste research. Governments and international organizations like the FAO continue to prioritize high yield paradigms, which are quite tolerant of inefficiency and waste. As such, while many governments have invested extensive resources to increase food productivity, no effective initiatives are in place that reduce overproduction and overconsumption (Smil, 2004).

Due to data and resource limitations, researchers and policy makers often restrict food loss and food waste estimates to portions of supply chains that are of most interest to them, or to where loss-reducing interventions are believed to be most effective or cost-efficient (Hodges et al., 2011). These considerations may, in part, explain the limited growth of peer-reviewed or major published studies that estimate the amount or monetary value of food waste and its causes (Buzby & Hyman, 2014).

2.4. Trends of food loss and food waste in developing and industrialized countries

Food loss and food waste trends in Canada mirror similar patterns found in other industrialized countries. While it is not a focus of this paper, it is important to note that patterns of food loss and waste differ between developing and industrialized regions. High rates of food loss can be found in both developing and industrialized regions but differ regarding where the majority of food loss occurs along food supply chains. The degree of food loss greatly depends on specific characteristics of each country and region, including economic and climactic conditions, production systems, available infrastructure, and market and consumption trends (Grizzetti, Pretato, Lassaletta, Billen & Garnier, 2013). Table 1 summarizes some main differences regarding food loss and food waste between industrialized and developing regions.

	Industrialized regions	Developing regions
Per capita food loss	280-300 kg/year (Europe & North America)	120-170 kg/year (Sub-Saharan Africa & South/SE Asia)
Per capita food wasted by consumers	95-115 kg/year (Europe & North America)	6-11 kg/year (Sub-Saharan Africa & South/SE Asia)
Stages of FSC where majority of food loss occurs	retail, consumption	post-harvest, processing
Main causes for food loss and food waste	retailer behaviours; consumer behaviour	Lack of infrastructure; financial and technical limitations

Table 1: Summary of main differences regarding food loss and food waste between industrialized and developing regions.
Adapted from: Gustavsson et al., 2011; Parfitt et al., 2010; Gooch et al., 2010

In developing countries more than 40% of food losses occur at post-harvest and processing levels. In contrast, in industrialized countries more than 40% of food losses occur at retail and consumer levels. In general, industrialized regions generate both higher

per capita food loss and per capita food waste by consumers compared to developing regions. In Europe and North America, per capita food loss is 280-300 kg/year compared to 120-170 kg/year in Sub-Saharan Africa and South/Southeast Asia. Per capita food waste by consumers is 95-115 kg/year in Europe and North America, compared to only 6-11 kg/year in Sub-Saharan Africa and South/Southeast Asia (Gustavsson et al., 2011). The percentages of food loss for fruits and vegetables are consistently high among both industrialized and developing regions and the differences in the location of food loss along the FSC follow global food waste patterns (*ibid*). Chart 1 compares the percentage of food losses and waste of the edible parts of fruits and vegetables that were produced for human consumption among different regions. In industrialized regions, like Canada, the majority of food losses and waste for fruits and vegetables occur during agricultural production and consumption. In developing regions, food loss and waste occurs primarily within agricultural production, postharvest, and distribution stages (*ibid*).
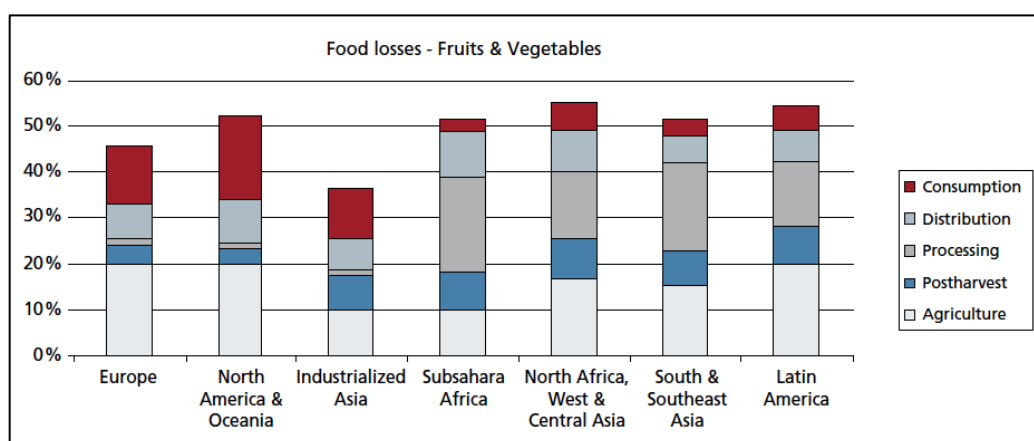
Chart 1: Percentage of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions.
Source: Gustavsson et al., 2011, p. 7.

General causes of food loss and food waste vary between industrialized and developing regions. In developing regions, inefficient post-harvest agricultural systems and a lack of infrastructure are the main causes for food loss (Parfitt et al., 2010). This may include a lack of proper cooling and storage facilities; inadequate market systems; and inefficient harvesting techniques (Hodges et al., 2011). In contrast, technologically advanced production and processing systems and efficient cold chains have reduced food losses occurring earlier in the FSC in industrialized regions (Grizzetti et al., 2013). As such,

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the majority of food waste is a result of retail and consumer behaviours (Gooch et al., 2010; Quested & Parry, 2011; Griffin et al., 2009; Hodges et al., 2011). Consumer behavioural responses may be facilitated in part by the structure of food retailing and manufacturing. Some identified causes of consumer food waste include having high aesthetic standards for produce, cooking or preparing too much, not using the food in time, and a lack of confidence using leftovers (Gooch et al., 2010). At the retail level, some of the main drivers of food waste in industrialized countries include: unnecessary inventory, excessive transportation, lack of coordination along the chain, and high quality standards (Meno, Adenso-Diaz & Yurt, 2011; ERS, 2011; Gooch, et al., 2010; Parfitt et al., 2010). In addition, a large body of literature focuses on the growing power held by a concentrated number of agri-food corporations and major supermarket chains (McMichael, 2009; Burch & Lawrence, 2009; Holt-Giménez & Shattuck, 2011). Due to their exceptional buying power, food retail strongly influences other actors along the food supply chain, which may further affect the generation of food waste (Richards, Bjørkhaug, Lawrence & Hickman, 2013). As such, the effectiveness of approaches for reducing food loss and food waste will be highly dependent on a country's (or region's) particular geographical, political, and cultural climate.

SECTION 3: METHODOLOGICAL FRAMEWORK

3.1. Research questions

This paper's overall objective is to quantitatively and qualitatively analyze food waste within Ontario's domestic fresh strawberry supply chain between the years 2008 and 2012, inclusive. The domestic fresh strawberry market consists of unprocessed strawberries that are grown, sold, and consumed within the province of Ontario. The recent removal of grading standards for fresh market commodities by Ontario's Ministry of Agriculture, Food and Rural Affairs (OMAFRA) presents a unique opportunity to explore the relationship between grading standards and food waste. Previous studies postulate that grading standards cause food waste by preventing growers from selling subgrade produce to secondary markets. A comparative analysis of food waste before and after the removal of Ontario's produce grading standards may shed light on this relationship. By incorporating

the perceptions of supply chain actors with existing data on food waste, a better understanding of food waste emerges, which may further promote more effective food waste strategies. To meet this paper's overall objectives the following research questions will be addressed:

- Where is food waste most prevalent along Ontario's domestic fresh strawberry food supply chain? How indicative is this waste of wider food system problems?
- What are the perceived challenges and opportunities for actors within this supply chain in regards to food waste?
- Has the removal of Ontario's grading standards for fresh market commodities (Regulation 119/11 under the Food Safety and Quality Act, 2001, effective July 1, 2011), had any noticeable or perceived effects on reducing or mitigating food waste within the food supply chain?
- Where should future policy and programming efforts be focused within the food supply chain in order to be most effective in reducing waste?

3.2. Selection of supply chain for analysis

Following a review of a select number of fresh market commodities in Ontario, the fresh strawberry supply chain was chosen as it met the most criteria considered amenable to this study's research aims. Selection criteria were partly derived from findings in the literature that describe conditions impacting waste generation. For example, waste generation is likely to occur for fresh market commodities that are physically more susceptible to damage and spoilage. Tables 2 and 3 show the comparison between blueberries, strawberries, and cherries against this study's selection criteria.

Criteria	Strawberry	Cherry	Blueberry
Has a limited number of import sources.	✓	✓	?
Has a limited number of export destinations.	✓	✓	?
Has a confined harvest season of no more than two months.	✓	✓	✓
Has a sizeable fresh market in Ontario.	✓	✓	✗
Is easily susceptible to spoilage.	✓	✓	✓
Was subjected to changes of Ontario's grading standards for fresh market commodities (Regulation 119/11 under the Food Safety and Quality Act, 2001).	✓	✓	✓
Has accessible data from government, industry and academic sources.	✓	✓	?
✓ = meets criteria, ✗ = does not meet criteria, ? = unclear if criteria met (due to unavailable information)			

Crop name	International Harmonized System Number(s)	Number of import sources	Number of export destinations (2011)	Harvest (Growing?) season	Marketed production (2011, metric tonnes)	Susceptible to spoilage	Subject to Reg. 119/11 (Food Safety and Quality Act, 2001)
Strawberry	081010: Strawberries, fresh	11 (92% from US)	081010: 0	Late June-early July	4,731	Yes	Yes
Cherry	080920: Cherries, fresh 080921: Sour cherries, fresh 080929: Cherries, fresh, other than sour cherries, nes	14 (97.5% from US)	080920: 0 080921: 0 080929: 1	June-July	080920: 694 080921: 3,173	Yes	Yes
Blueberry	08104011: Blueberries, wild, fresh 08104012: Blueberries, cultivated, fresh	n/a	n/a	Early July-late August	868	Yes	Yes

Tables 2 and 3: A comparison of three fresh market commodities against this study's selection criteria.
Adapted from: Statistics Canada, 2014a.

Although fresh cherries met all of the research selection criteria, this commodity was rejected due to potentially confounding data. A review of preliminary data sets shows inconsistent reporting, with some failing to distinguish values between sour cherries and sweet cherries. As this study focuses exclusively on fresh markets, the potential inability to isolate data on sour cherries, which are largely directed to processing markets, is problematic. Fresh blueberries were not chosen based on the fragmented availability of data and its relatively small fresh market.

Owing to its physical characteristics and confined harvest season, fresh strawberries are prone to spoilage and waste, which make it ideal for a food waste analysis. However, the main reason for choosing Ontario's fresh strawberry supply chain is that it is the easiest to isolate domestic production and consumption data. Additionally, in order to maximize the potential benefits of this study's findings on reducing food waste, fresh strawberries were chosen due to their sizeable fresh market in Ontario.

3.3. Analytical frameworks

3.3.1. Supply chain analysis

 Supply chain analysis is the primary analytical framework guiding this study, which is the most commonly used organizational and conceptual framework found in the literature. A supply chain refers to a system of organizations, actors, activities, informational interchanges, and resources involved in bringing a product or service from supplier to customer (CSCMP, 2013). In the context of food production, these activities include farm production, trade, and support to get food commodities to the end consumer (e.g. transportation, processing). Similarly, a value chain extends the notion of a traditional supply chain by identifying the value being added to the product or service at each stage of the chain as it is being transformed (Sanogo, 2010). Supply chain analysis conceptually organizes and integrates multiple actors and stages within a specific supply chain (Hodges et al., 2011). As such, it departs from previous approaches that tended to focus on individual sectors (Jackson, Ward & Russell, 2006). It details both the structural and dynamic factors that affect the contributions of each actor to the chain and provides a clearer picture of the links between producers and consumers (Sanogo, 2010). Critics of this framework point to inconsistencies in interpretations of the supply chain concept; others argue that supply chains oversimplify the complexity of food systems and the relationships between actors (Jackson et al., 2006). While acknowledging these limitations, supply chain analysis remains a useful analytical framework, especially as global food chains continue to expand. By understanding the integrated nature of these chains, supply chain analysis may lead to greater systemic efficiency (Hodges et al., 2011).

3.3.2. Waste and food recovery hierarchies

 This study is also informed by the European Commission's Waste Hierarchy, which outlines a priority order for informing waste legislation and policy. As seen in Figure 2, of highest priority in this framework is waste prevention (non-waste), followed by preparing for reuse, recycling, recovery, and lastly disposal (EC, 2012). A parallel hierarchy created by the United States Environmental Protection Agency (EPA) also informs this paper. The EPA's Food Recovery Hierarchy uses a priority order similar to the EU's Waste Hierarchy,

but applies it specifically to preferred approaches for food recovery. As seen in Figure 3, waste prevention, or source reduction, is similarly prioritized. In the case where food waste is generated, a priority order informs how waste should be used (EPA, 2014). The second most preferred option is recovering food waste to feed hungry people, followed by feeding animals, industrial use, and composting. Similar to the EC's Waste Hierarchy, the disposal of waste is least preferred by the EPA.
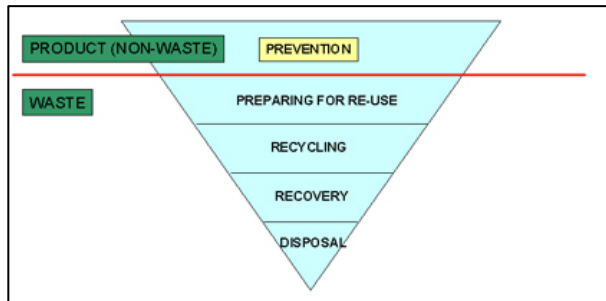
Figure 2: The EC's Waste Hierarchy
Source: EC, 2012
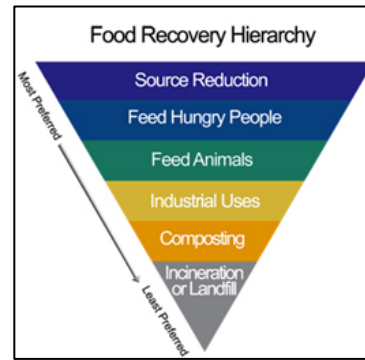
Figure 3: The EPA's Food Recovery Hierarchy
Source: EPA, 2014.

3.3.3. ESR Framework

Suggested short-, medium-, and long-term food waste reduction strategies are organized using the efficiency-substitution-redesign (ESR) framework. The ESR framework identifies progressive strategies, organized in increasing order of the required resources and time needed for their implementation. This framework is useful as it can be applied to describe on-farm strategies, but it can also be applied to the analysis of institutions, the process of decision-making, and to the contents of the decision (Hill & MacRae, 1996).

3.4. Data collection and scope of study

This study's methodological approach is designed to compensate for the fragmented availability of food waste data. This paper begins with a comprehensive review of relevant food waste studies in order to quantitatively estimate a range of food waste occurring along Ontario's fresh strawberry supply chain. As a supplement to this review, surveys with supply chains actors qualitatively analyze food waste to confirm and adjust this

study's initial estimated range. A resource map adapted from WRAP UK's 2011 study, *Fruit and vegetable resource maps* (Terry et al., 2011) summarizes findings. [1]

3.4.1. Review of comparable food waste studies

This paper analyzes information from complementary food waste studies and data sets in order to quantitatively estimate the range of food waste occurring in Ontario's fresh strawberry supply chain. Studies that identify data specifically for fresh strawberries are prioritized, but in the event this is not available, values for fresh fruits and/or fresh fruits and vegetables are used in place. While this research utilizes Canadian-based studies, there is a noted lack of available pertinent analysis. As such, this paper relies heavily on findings from the United States, Western Europe, and occasionally Australia, where a majority of food waste studies have been conducted. Fortunately, these regions have similar food market structures to Canada and make them more amenable for use. Every attempt is made to accurately adjust these figures for Canadian, and Ontarian, contexts. When applicable, any significant differences that may impact this study's conclusions will be identified.

To analyze Ontario's domestic fresh market, data on imported strawberries are considered, but not fully included in this analysis. A discussion on the decision to exclude import data is conducted later in this paper. Additionally, as this study focuses exclusively on Ontario's fresh market, food waste data occurring during processing and manufacturing are not included. However, strawberries that are removed from the fresh supply chain to be used in processing and manufacturing are accounted for. Averages over a five-year period (2008-2012, inclusive) are used in order to accommodate yearly fluctuations in strawberry production and consumption. To facilitate data collection, this study does not distinguish between food waste data occurring between organic and conventional growing methods. Although this aspect of analysis is welcomed, it is not considered feasible for this study. Where there are knowledge gaps, this study makes its own assumptions and estimations, based on food waste levels in comparable regions, commodity groups, and parts of the supply chain.

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[1] WRAP UK is a not-for-profit company funded by a number of governments and other public sector organization and is widely considered to be the leading authority on food waste research. WRAP UK publishes numerous studies on food waste prevention and recovery, including Terry et al.'s (2011) "Fruit and vegetable resource maps", which traces the amount of food waste occurring along ten commodity supply chains in the United Kingdom.

3.4.2. Surveys

Surveys were conducted with supply chain actors in order to confirm and adjust estimates of food waste, as well as to collect and analyze qualitative data on the perceived causes of food waste, and the challenges and opportunities for current and future food waste strategies. Written surveys, typically completed electronically, were preferred for data collection; however, surveys were also conducted over the telephone at the participant's request. Identifying information was omitted to protect anonymity, if requested . The survey consisted of fifteen short-answer questions, grouped into five sections: Company overview; Occurrence of food waste; Destination of food waste; Causes of food waste; and Food waste policy. An area was also provided at the end of the survey for participants who wished to leave additional comments. While similar, two separate versions of this survey were created for producers and for retailers. Both producer and retailer survey templates can be found in Appendix 1 and Appendix 2, respectively. Efforts were made to select a range of participants, including large-, medium- and small-scale operators and from different geographic areas across Ontario. There was a low number of survey responses from producers and retailers as the duration of this research project coincided with the lead up to harvest season; retailers were also skeptical of revealing corporate information. To overcome this limitation, this study gleaned past interviews of supply chain actors from industry sources, newspapers, magazines, and peer-reviewed journals. While there is value in collecting primary data at the consumption level, it was not considered feasible for this study. Consumer marketing studies, which survey thousands of Canadians, provide a more accurate and comprehensive assessment of consumer food waste behaviours.

3.4.3. Resource maps

This study adapted resource maps from WRAP UK's (Terry et al., 2011) study on fruit and vegetable food waste in order to summarize its findings. As seen in Figure 4, a resource map indicates the percentage range for waste and the main causes of waste for each stage of the supply chain. The supply chain is shown sequentially for presentation and does not necessarily imply linear relationships along the chain.
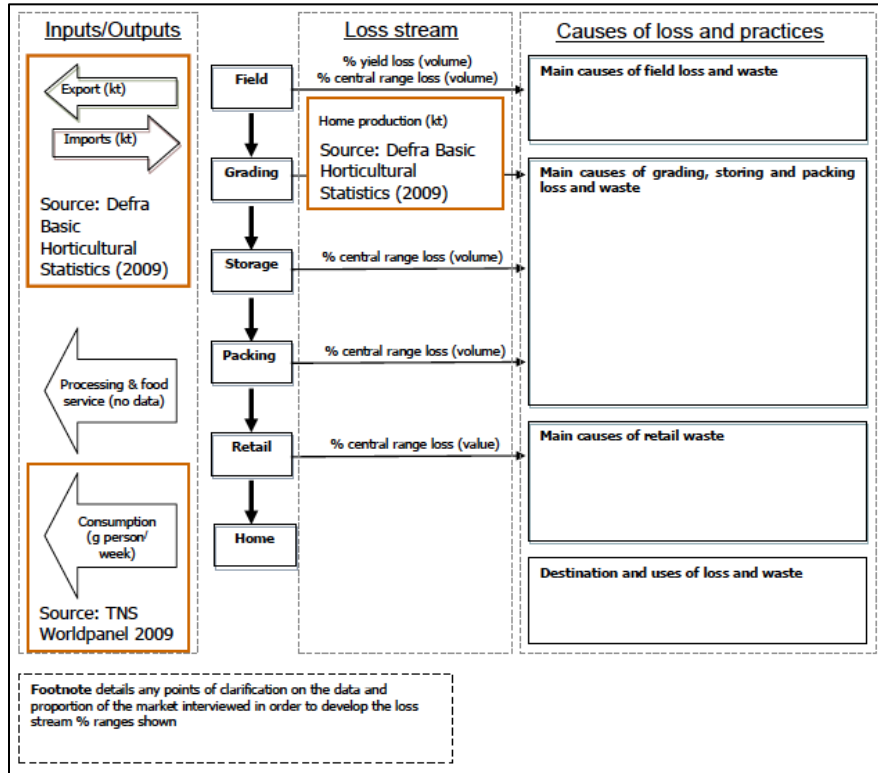
Figure 4: Outline resource map
Source: Terry et al., 2011, p. 25.

Due to this study's extrapolation of data from various sources, conclusions on the occurrence and causes of food waste should be considered as a best estimate, reflecting a snapshot of food waste in Ontario's domestic fresh strawberry supply chain.

SECTION 4: ONTARIO'S DOMESTIC FRESH STRAWBERRY SUPPLY CHAIN

4.1. Overview

Canada's horticultural sector is one of the largest agri-food industries in Canada, generating full time employment for 200,000 full-time workers. In 2007, production, packing and processing of Canadian horticultural crops generated $29 billion in economic activity (CHC, 2007). In particular, strawberries continue to be an important crop, with wild and cultivated varieties found in every province. In 2009, strawberries accounted for four percent of all hectares devoted to fruit (Statistics Canada, 2010).

Ontario's fresh strawberry supply chains are often short, with the basic structure being similar to those found in the United States, the United Kingdom, and other regions of

Canada. A simplified illustration of Ontario's fresh strawberry supply chain is shown in Figure 5, while a more detailed illustration is shown in Figure 6. This study focuses on waste occurring along the supply chain for domestically grown strawberries specifically, which is similar in structure but excludes imports (imports shaded red in Figures 6 and 7).
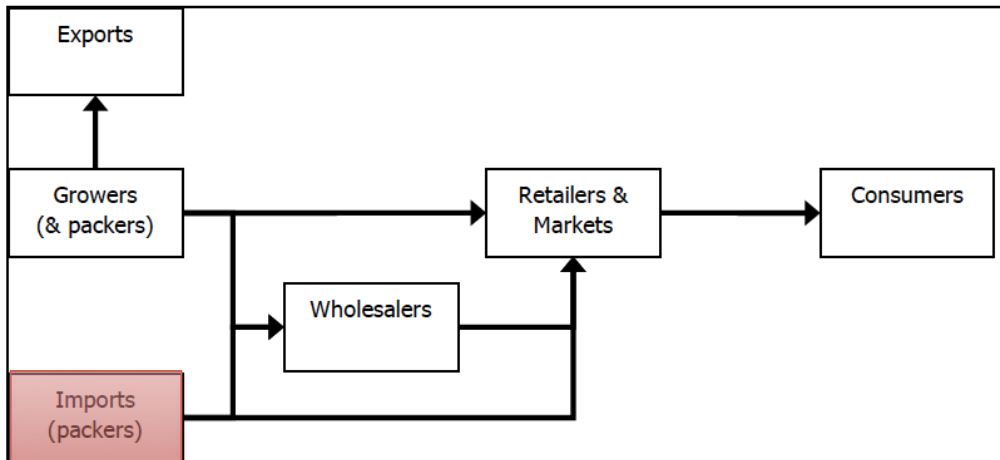
Figure 5: Simplified structure of Ontario's fresh strawberry supply chain. For domestic fresh strawberry supply chains, items associated with imports (shaded red) are not included.
Adapted from: Terry et al., 2011.
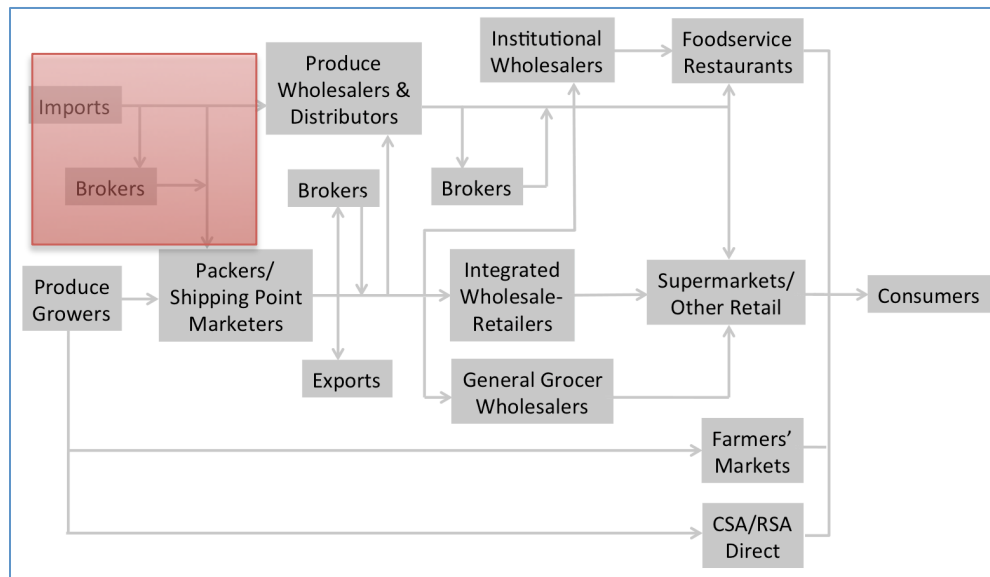
Figure 6: Detailed structure of a fresh produce supply chain, which is similar to Ontario's fresh strawberry supply chain. For domestic fresh strawberry supply chains, items associated with imports (shaded red) are not included.
Adapted from: Nickel-Kailing, 2013.

For organizational purposes, this study illustrates supply chains as linear, sequential processes; however, the movement of strawberries can bypass steps, go through additional

steps, and move back and forth freely along the chain. There is also considerable vertical integration and consolidation in the industry, particularly within the retail stage of the chain.

4.2. Strawberry biophysical characteristics

Strawberry plants are one of the least hardy herbaceous perennials and due to their delicate flesh they are highly susceptible to damage. Contrary to popular belief, strawberries are technically neither a fruit nor a berry. Strawberries are botanically classified as an accessory fruit, which is a fruit in which some of the flesh is derived not from the ovary, but from some adjacent tissue exterior to the carpel (Esau, 1977). Strawberries belong to the *Rosaceae* family, with all varieties belonging to the *Fragaria* genus. In their first year, strawberry plants grow vegetatively from runners, cuttings, or root suckers (Gardner, Slingerland & Fisher, 2006). As seen in Figure 7, strawberry plants reproduce by sending out their roots, via runners, which then produce new daughter plants. Daughter plants grow and bear fruit and can also be used to start a new plantation of strawberry plants (OBGA, 2014).
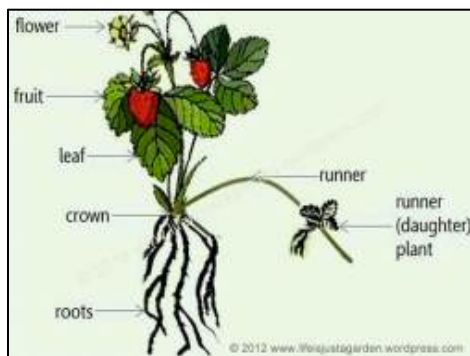
Figure 7: An illustration of a typical strawberry plant.
Photo credit: Life is just a garden, nd.

Most Ontario strawberries are grown using matted row systems, but plasticulture systems are required for certain varieties. Plantings typically occur in the spring or fall, with fall plantings requiring more care if temperatures are too cold (OBGA, 2014). During the winter season, plants are protected from cold temperatures using straw or plastic mulch (Gardner et al., 2006). Although strawberry plants can be planted in any garden soil, richer soils produce larger crops (OBGA, 2014). As such, strawberries tend to be grown on the best agricultural soils in Ontario (Gardner et al., 2006). Strawberry plants grow best in cool,

20

moist climates, but should still receive at least six hours of direct sunlight. Due to their shallow roots, excellent drainage is also required to prevent root rot (OBGA, 2014).

The two major types of strawberries grown in Ontario are June bearing and Everbearing. June bearing varieties remain the dominant choice among Ontario strawberry growers. The advantages of growing June bearing varieties are that they produce a higher yield and larger sized berries. They are classified according to early, mid-season, and late varieties, all of which produce a single, large crop in a year (UIE, 2014). June bearing varieties bear fruit early in the spring season, and as their namesake suggests, this occurs typically in the month of June. One constraint of June bearing strawberries is that the harvesting period is short, lasting for about three weeks (OBGA, 2014). Everbearing varieties are increasing in popularity amongst strawberry growers (AFFC, 2005). Unlike June bearing varieties, which produce only a single crop, Everbearing varieties produce three periods of fruit during the spring, summer, and fall. However, Everbearing plants have smaller yields and produce relatively smaller fruit (UIE, 2014). In addition, growing Everbearing plants is more labour intensive as they must be grown using plasticulture systems. Plasticulture production is a high-density system where plants are grown on raised beds with trickle irrigation. Plastic mulch, as opposed to straw mulch, is used to provide weed control. Although machines can put down plastic mulch and raised beds, each Everbearing plant must be put in by hand (Gardner et al., 2006). Despite increased labour requirements, Everbearing varieties are still favoured by growers for their extended harvest period. Nonetheless, growers choose which type and variety to plant based on preferred characteristics specific to their market, such as preserving quality, disease resistance, and season of maturation (UIE, 2014).

Harvesting strawberries is labour intensive, requiring each fruit to be hand harvested to protect its delicate flesh. Strawberries are typically harvested for two to four years after the initial planning (Gardner et al., 2006). According to the Ontario Berry Growers Association (OBGA), when harvesting strawberries, they should be plump, firm, and deep-colored, with bright green caps and no signs of mould or soft spots. Strawberries should be consumed as soon as possible after harvesting or purchasing. Once at home, strawberries should be stored in the refrigerator for one to two days, as warm

temperatures cause browning. To minimize rot, strawberries should only be washed and hulled just before using or consuming them (OBGA, 2014).

4.3. Strawberry production in Canada and Ontario

After Quebec, Ontario is the second-largest producer of strawberries in Canada (AAFC, 2005). As seen in Table 4, between the years 2008 and 2012 Ontario growers harvested a yearly average of 1,007 hectares of strawberries, with a marketed production of 5,647 tonnes, and farm value of $20,211,000 CAD; this represents 31.7%, 28.4%, and 29.6% of Canada's strawberry production values, respectively.

		2008	2009	2010	2011	2012	5-year average (2008-2012)
Harvested/Bearing Area (ha)	**Canada**	3,492	3,185	3,025	3,091	3,091	3,177
	Ontario	1,234	998	965	910	927	1,007
	%	35.3	31.3	31.9	29.4	30.0	31.7
Marketed production (metric tonnes)	**Canada**	20,366	19,531	19,093	20,388	19,888	19,853
	Ontario	6,260	6,210	5,857	4,731	5,178	5,647
	%	30.7	31.8	30.7	23.2	26.0	28.4
Farm Value ($'000) not including government subsidy payments	**Canada**	61,250	69,178	68,065	71,626	70,826	68,189
	Ontario	19,420	22,563	20,805	18,644	19,622	20,211
	%	31.7	32.6	30.6	26.0	27.7	29.6

Table 4: Strawberry: Area, Production, Farm Value, Price and Yield, Ontario, 2008-2012
Adapted from: Mailvaganam, 2013; Statistics Canada, 2014b.

Strawberries grow in all five geographic regions identified by the national Census of Agriculture: Southern Ontario, Western Ontario, Central Ontario, Eastern Ontario, and Northern Ontario. As strawberry production requires temperate climates for optimal growth, the amount of strawberries grown in each region is relative to its geographic location. As seen in Table 5 in 2011, Southern Ontario accounted for over 42% of Ontario's marketed production (1,966 tonnes) and led all regions in the number of farms reporting growing strawberries (205) and harvested hectares (535); in contrast, Northern Ontario accounted for only 6% of Ontario's marketed production (291 tonnes) and trailed all regions in number of farms reporting growing strawberries (40) and harvested hectares (89) (Statistics Canada, 2012c).

Region	Number of farms reporting growing strawberries	Harvested hectares	Marketed production (metric tonnes)
Southern Ontario	205	535	1,966
Western Ontario	193	248	838
Central Ontario	130	242	874
Eastern Ontario	95	214	757
Northern Ontario	40	89	291
Ontario (Total)	663	1,329	4,731

Table 5: A comparison of Ontario's growing regions, 2011. The sum of regional values is not equal to Ontario's total value due to rounding.
Source: Statistics Canada, 2012c.

In 2011, 663 farms reported growing strawberries in Ontario (Statistics Canada, 2012c). While most strawberry growers have small acreages of strawberries in addition to other crops, strawberry production market share is dominated by a small number of large-scale farms. In 2006, as evidenced in Table 6, less than 20% of strawberry farmers had over 4 hectares (10 acres) in production, however these growers produced over 70% of the Ontario crop (Gardner et al., 2006).

Farm size	Total area (acres)	Percent of area	Number of farms	Percent of farms
0.1-0.5 acres	53	1.3	218	27.2
0.6-1.0 acres	106	2.5	111	13.9
1.1-1.9 acres	44	1.0	30	3.8
2.0-4.9 acres	503	11.9	173	21.6
5.0-9.9 acres	964	22.7	145	18.1
10.0-29.9 acres	1,711	40.3	108	13.5
30.0-49.9 acres	381	9.0	10	1.3
50.0 acres and over	481	11.3	6	0.8
Total	4,243	100.0	801	100.0

Table 6: Breakdown of Ontario strawberry by farm size and number of farms.
Source: Gardner et al., 2006.

The Ontario Berry Growers Association (OBGA) acts as the main representative for Ontario's strawberry growers and other berry growers. Its purpose is to advance Ontario's berry industry through increased research activities, promoting better cultural/harvesting and marketing practices, and through a variety of rights and patents. Its voluntary membership includes approximately 200 growers who produce 80% of Ontario's berry crops (OBGA, 2014). Other grower associations include the Eastern Ontario Berry Growers Association and the North American Strawberry Growers Association.

4.3.1. Canada's and Ontario's fresh strawberry industry in decline

Strawberry production in Canada and Ontario has steady declined within the last ten years, with fewer volumes of marketed production, fewer strawberry farms, and fewer hectares planted (APFFQ, 2013). Chart 2 shows that over a ten year period between 2003 and 2012, marketed production of strawberries in Canada and Ontario have declined 19% and 30%, respectively. According to Canada's 2006 and 2011 Census of Agriculture (Statistics Canada, 2007; Statistics Canada, 2012c), from 2006 to 2011, the number of farms reporting growing strawberries declined 11% (2,479 to 2,202) and the number of hectares for strawberry production declined 14% (5,205 to 4,486). Following the national trend, strawberry production in Ontario shows similar decline. From 2006 to 2011, the number of farms reporting growing strawberries declined by 17% (801 to 663) and the number of hectares for strawberry production declined by 23% (1717 to 1329) (*ibid*).

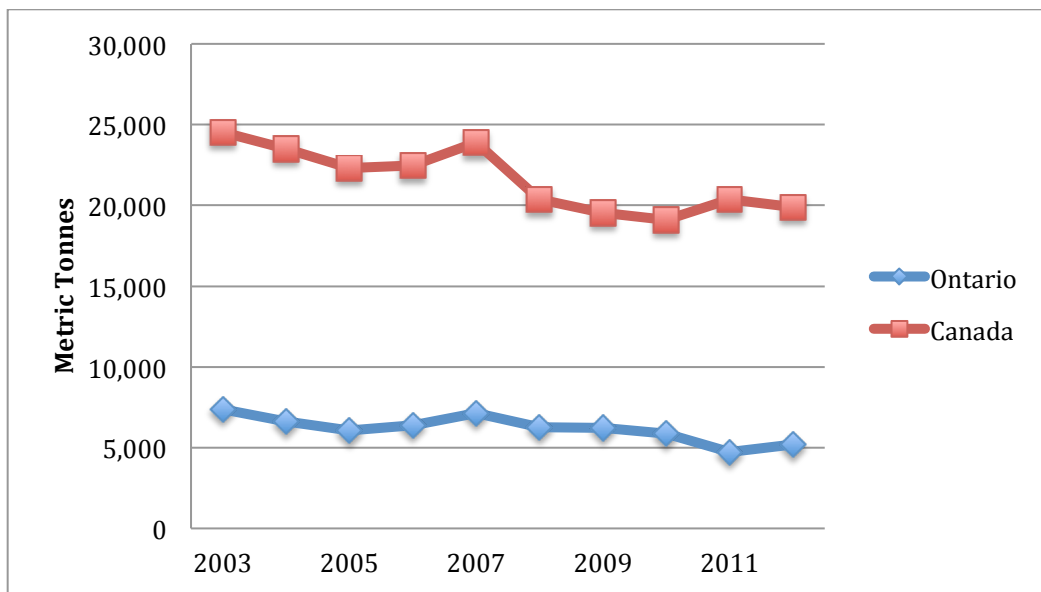**Chart 2: Marketed production of fresh strawberries in Ontario and Canada, 2003-2012.**
Adapted from Statistics Canada, 2014b.

The decline in the number of strawberry farms is partly a result of consolidation in the sector over the last ten years. Another reason for this decline, which will be expanded upon later in this paper, is the increasing reliance on strawberry imports in Ontario and Canada.

4.4. Post-harvest handling and distribution

4.4.1. Cooling

Once strawberries are harvested, they must be quickly cooled to remove field heat. To protect its freshness, temperature and humidity levels should be managed during all stages of the supply chain (Terry et al., 2011). As such, refrigeration systems play a critical role in maintaining the cold chain. A majority of Ontario strawberry farms use walk-in coolers, however, larger operations may use more sophisticated forced-air cooling systems (Porter, 2007).

4.4.2. Grading

Government standards determine the allowable shape, size, colour, maturity, and general allowances for products imported or grown in a jurisdiction (Kohn, 2011). As of July 1, 2011, fresh strawberries grown and sold within Ontario, and strawberries grown in Ontario destined for processing, are no longer subject to any provincial grading standards. Regulation 119/11 Produce and Maple Products under the Food Safety and Quality Act, 2001, established the removal of these grading standards, which replaced Regulation 378 of the Farm Products Grades and Sales Act. In addition to the removal of grading standards, Regulation 119/11 simplified labeling requirements, removed container standards, and clarified food safety provisions. Regulation 119/11 only applies to products grown and sold within Ontario; products destined for interprovincial or international trade must still be in accordance with federal grading requirements ("Food and Safety Quality Act", 2001). Federal strawberry standards are set out under the Fresh Fruit and Vegetable Regulations of the Canada Agricultural Products Act, 1985. To be classified as Canada No.1, strawberries must be well formed; free from mould and surface moisture; be of mature colour; be generally free from damage or defect; and have a minimum diameter of 16 mm (⅝ inch). These grading standards allow for general tolerances; for example, up to 10 percent by count of strawberries in a lot inspected at the time of shipping or repacking may have defects, but no more than 2 percent can be affected by decay ("Fresh Fruit and Vegetable Regulations", 1985). The complete federal grades and standards for strawberries can be found in Appendix 3.

4.4.3. Packaging

Packaging is used to protect strawberries from damage and excessive handling along the supply chain. Packaging for Ontario strawberries is variable and depends on the resources and preferences of the grower and/or buyer. Figure 8 shows a sample of packaging options for strawberries in Ontario. Cardboard baskets or plastic buckets are used by pick-your-own operations and sold by total volume or weight. At farmers' markets, strawberries are typically sold in half- and full-quart reusable plastic baskets or single-use cardboard baskets. At major food retailers, Ontario strawberries are sold in half- or full-quart reusable plastic baskets with plastic lids. Packages or usually delivered to stores in plastic returnable trays or corrugated trays. As seen in Figure 9, imported strawberries are always sold in plastic PET or rPET packages with clip on lids, available in one- or two-pound weights.

Figure 8: Packaging options for Ontario strawberries.
Clockwise from bottom left: Corrugated cardboard trays; Half-quart cardboard basket; Half-quart reusable plastic basket; Full-quart reusable plastic basket with plastic PET cover; Cardboard basket
Photo credit: Tree Hugger, 2011; MmmTasty, 2009; Foodlink, 2010; Multi-testing Mommy, 2014; Little Piggy, 2014.

Figure 9: Plastic PET or rPET packaging typically used for imported strawberries.
Photo source: Dying for Chocolate, 2011.

4.4.4. Transportation

There is a lack of detailed Canadian data on food transport, particularly in regard to upstream and final delivery (MacRae et al., 2013). However, it is likely that most strawberries are transported across Ontario by refrigerated, or reefer, trucking. In Ontario, there are over 60 refrigerated transportation companies with the highest concentration of companies found in the Greater Toronto Area. There are approximately 16 companies in Mississauga, 6 in Brampton, and 3 each in Concord, Milton, and Toronto. In order to maintain the cold chain, many refrigerated trucks are equipped with state-of-the-art electronic temperature monitoring systems (OMAFRA, 2009). The size and sophistication of refrigerated trucks vary according to the size and resources of each producer. For example, a study by MacRae et al. (2013) compared a typical supply route for California strawberries imported into the province with local production on a farm near Barrie, Ontario. California strawberries were transported using refrigerated 18-wheel trucks to the Ontario Food Terminal, which were then transported to an independent retailer in Toronto. Transportation logistics are quite sophisticated, with plastic wrap and CO_2 injection to ensure the strawberries do not spoil on the 33-hour journey. In contrast, the local strawberries from the Barrie farm were delivered directly to a retailer using a smaller, less advanced 14-ft. refrigerated reefer.

4.5. Food retail and foodservice

In Ontario, the majority of domestic strawberries are sold using three primary retail channels: U-pick and on-farm markets; public markets and wholesalers; and major distributors. Approximately 30% of domestic strawberries in Ontario are sold on-farm,

either through U-pick (pick-your-own) or pre-picked alternatives. Smaller scale strawberry farms typically use these direct-to-consumer retail channels. Wholesalers connect producers with food retailers, food service and catering, and the public sector. In Canada, approximately 40% of domestic strawberries are sold through wholesalers and at public markets (APFFQ, 2013). Convenience stores and smaller grocery retail chains are often supplied by wholesalers, but can also source from distribution centres operated by larger grocery retailers. The main services provided by wholesalers are warehousing, transportation, product consolidation, inventory management and retail or catering advisory services (Arbulu, 2012). Approximately 30% of domestic strawberries are sold using distribution centres (APFFQ, 2013). Many large supermarket chains rely on strawberries delivered through centralized distribution centres. In fact, all major Canadian supermarket chains maintain distribution centres, which supply not only their own store outlets, but also franchised stores and independent grocers. This method of retail is more common among larger producers, who are capable of growing the volume of strawberries required by major food retailers (Arbulu, 2012). While on-farm and public markets remain the primary markets for domestic strawberries, the volume sold using major distributors is increasing (APFFQ, 2013).

4.5.1. Food retail

Ontario is the largest food retail market in Canada, leading in both market share of food sales and number of food retail stores, accounting for $25.9 billion, or about 32% of the market share ($81.5 billion) in 2009. Additionally, almost one-third (6,387 stores) of Canada's 21,242 food retail stores operate in Ontario (Roukhkian & Bardouniotis, 2011). Ontario's food retail sector consists of a range of food retail channels, including convenience stores, drug stores, grocery stores, supermarkets, and warehouse clubs. However, similar to trends found in other provinces, the majority of food sales continue to be sold through grocery stores and supermarkets, representing 63.5% of market share (Arbulu, 2012). Canada's food retail market is highly consolidated, with the top five food retailers (Loblaw Companies Inc., Sobey's Inc., Metro Inc., Walmart, Costco) accounting for approximately 80% of sales (Roukhkian & Bardouniotis, 2011).

4.6. Consumption

For Canadian consumers, food is the third largest household expenditure after shelter and transportation (Roukhkian & Bardouniotis, 2011). On average, each Canadian spends $3,494 per year on groceries. Although the amount spent on food purchases has increased over the years, food purchases as a percentage of total household expenditures has declined. Canadian households spent 18.7% of their total household expenditures on food in 1969, compared to 10.2% in 2009 (Arbulu, 2012). Almost three-quarters of Canadians shop for food at least once per week, with 77% of food being purchased directly from retail stores (Roukhkian & Bardouniotis, 2011). According to a recent survey conducted by Agriculture and Agri-Food Canada, the top four attributes influencing Canadian consumers, in order of importance, are: price, quality, freshness, and health/nutrition (Arbulu, 2012). On average, Canadians consume 3,645 calories per day per capita, which is in line with OECD averages (Roukhkian & Bardouniotis, 2011).

Strawberries, and berries in general, are a popular choice among Canadian consumers. According to a study by the Canadian Produce Marketing Association (CPMA), more than one-quarter of Canadians list berries as their favourite fruits. Additionally, 64% of Canadians say they buy berries at least weekly (Canadian Grocer, 2013). In 2007, Canadian spent 1% of all food purchases on fresh berries, with strawberries representing 35% of the fresh berry category (APFFQ, 2013). Demand for fresh strawberries by Canadian consumers has increased dramatically within the last 20 years. From 1991 to 2011, fresh strawberry consumption in Canada rose 94%, even outpacing the demand found in the United States. As seen in Chart 3, per capita consumption of fresh strawberries in Canada rose from 1.96 kg in 1991, to 2.2 kg in 2000, and to 3.81 kg in 2011 (APFFQ, 2013).
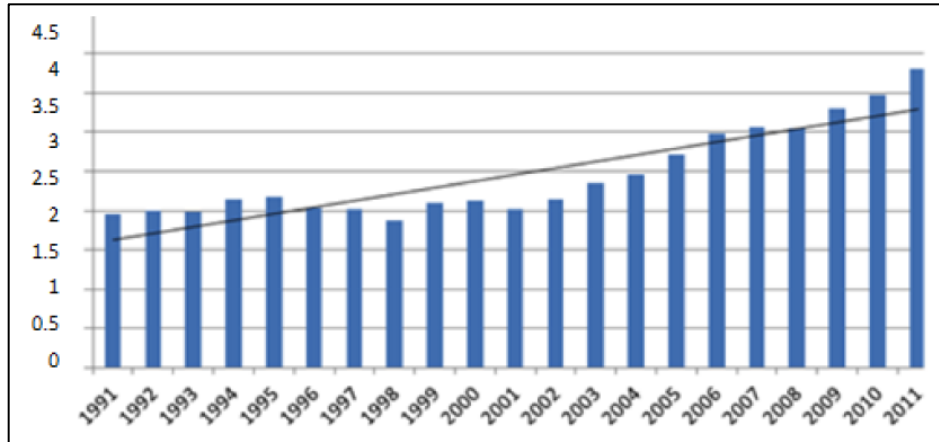
Chart 3: Consumption of fresh strawberries in Canada, 1991-2011 (kilograms).
Source: APFFQ, 2013, p. 3.

4.7. Fresh strawberry trade: Imports and exports

Ontario is a net importer of fresh strawberries. A small amount of strawberries are exported, however, this value is minimal, representing only 0.08% (4539 kg) of the province's total marketed production between 2008 and 2012 (Statistics Canada, 2014b). Ontario and Canada are relying more on imports than domestic production to meet the increased demand for fresh strawberries. Chart 4 shows that while there has been a gradual decrease in Canadian production of strawberries, there has been a concurrent increase in imported strawberries (APFFQ, 2013). In fact, within the ten year period between 2003 and 2012, strawberry imports into Canada and Ontario more than doubled from 59,394 to 127,017 tonnes, and from 34,948 to 72,167 tonnes, respectively (Statistics Canada, 2014b). The United States is overwhelmingly the main source for fresh strawberry imports, accounting for over 90% of all strawberry imports into Canada and Ontario in 2012. More specifically, the state of California produces over three-quarters of all fresh strawberries imports (Statistics Canada, 2014b).
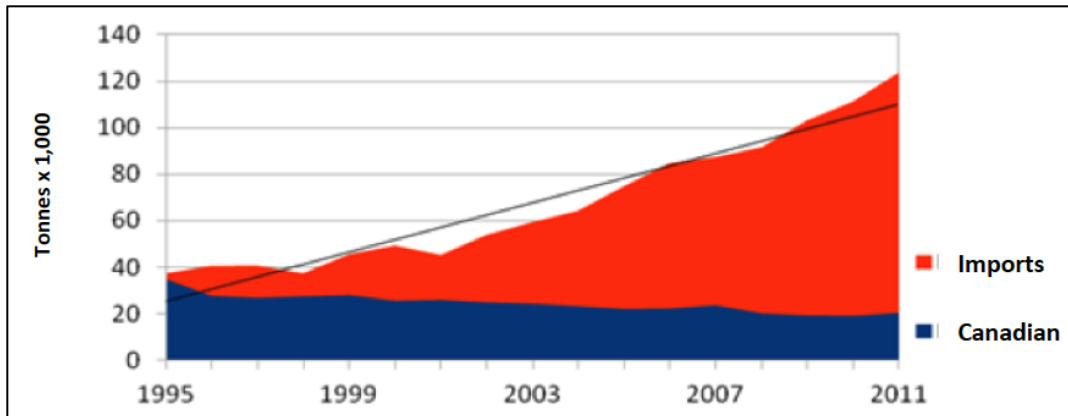
Chart 4: Consumption of fresh strawberries in Canada and supply origin.
Source: APFFQ, 2013, p. 4.

The rise in strawberry imports inside and outside of the domestic growing season is also due to increasing expectations by Canadian consumers for year-round availability of strawberries (Terry et al., 2011). Imports particularly increase prior to the Canadian production season, which is an especially sensitive time as buyers turn to domestic production (APFFQ, 2013). The shift towards strawberry imports partly explains the discrepancy between the increase in Canadian consumption of strawberries and the concurrent decrease in domestic strawberry production.

SECTION 5: QUANTIFICATION OF FOOD WASTE IN THE SUPPLY CHAIN

5.1. Overview

This study's estimates the occurrence of food waste along Ontario's domestic fresh strawberry supply chain based on a review of comparable food waste studies (see Table 7); on estimates provided by chain actors; and on the author's personal knowledge of the subject. Food loss percentages are expressed as the percentage of edible food that is lost from domestic production values, occurring within each stage of the supply chain. As summarized in Figure 10, this study estimates food loss percentages occurring during pre-harvest as 15%; post-harvest handling and distribution as 11%; retail as 10%; and consumers as 35%. The total loss percentage for the entire supply chain is 56% of all strawberries grown in Ontario, which is equivalent to an annual loss of 3700.5 tonnes of edible strawberries.

Domestic production
6,638.7 tonnes

• **Pre-harvest**
15%
• 995.8 tonnes

Domestic supply remaining at farmgate
5.642.9 tonnes

• **Post-harvest handling & Distribution**
11%
• 620.7 tonnes

• **Retail**
10%
• 502.2 tonnes

• **Consumers**
35%
• 1,582.0 tonnes

Loss-adjusted consumption of domestic strawberries
2,938.0 tonnes
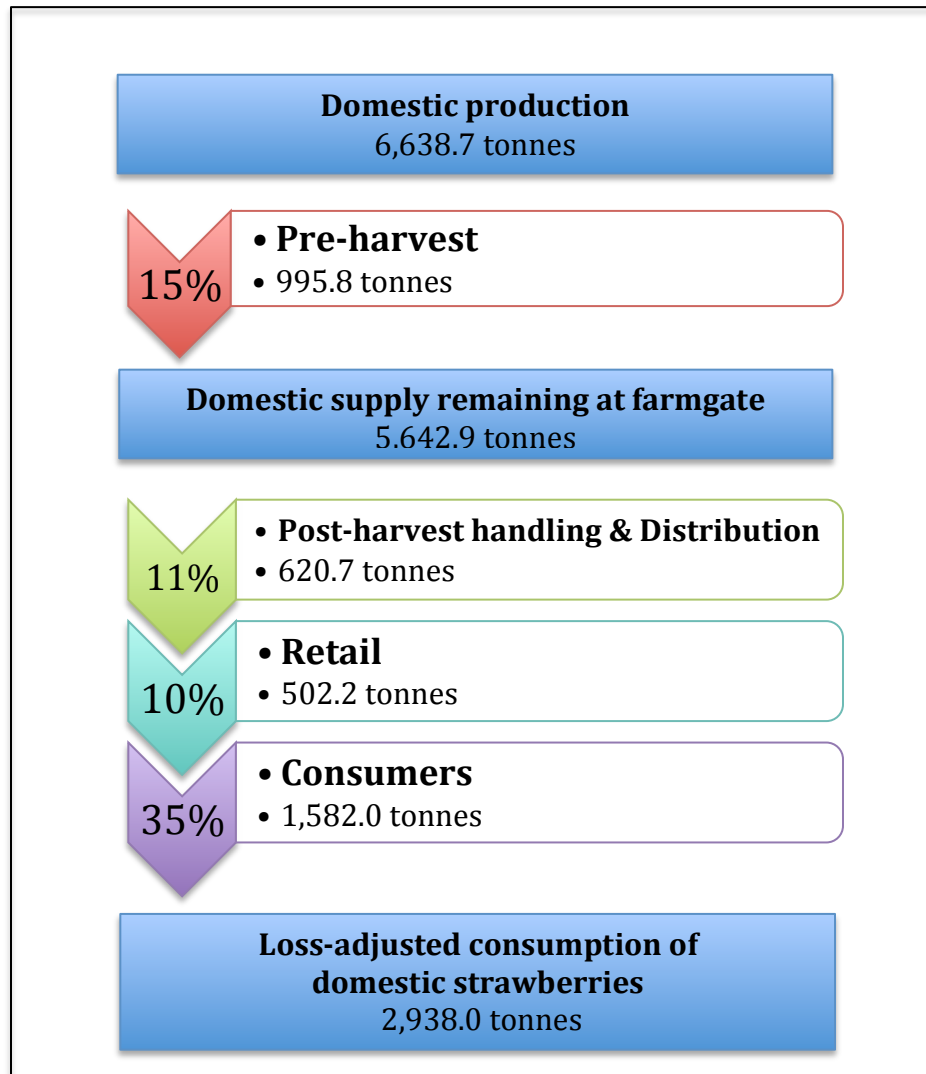
Figure 10: Food waste loss percentages at each stage of Ontario's domestic fresh strawberry supply chain, in relation to total domestic production.

The waste generated at each stage of the supply chain can also be expressed as a percentage of the total amount of edible strawberry waste generated in the chain. This is useful for identifying the relative contributions of each stage to waste generation, which may inform where reduction strategies should be targeted to be most effective. Summarized in Chart 5, the percentage of total waste for each supply chain stage is pre-harvest (27%), post-harvest handling and distribution (17%), retail (13%), and consumers (43%).
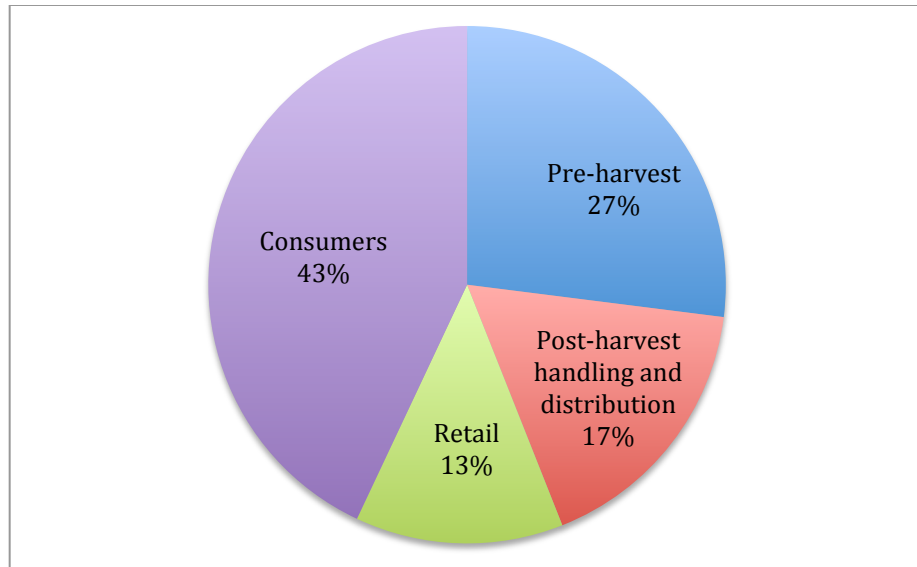
Chart 5: Edible waste generated at each stage of the supply chain, expressed as a percentage of the total amount of edible strawberry waste generated in the chain.

Table 7 compares relevant studies on food loss and food waste in fresh fruit and vegetable, fresh fruit, and fresh strawberry supply chains. Information on geographic area, year of study, and other classifications assist in comparing across studies, which differ in scope and methodology. The most comprehensive data on strawberry food waste is collected by the USDA's Economic Research Service (ERS), which annually updates commodity-specific databases on food availability and loss-adjusted food availability. The ERS' methodology for determining food availability and loss-adjusted food availability is widely used by leading authorities and scholars, including the FAO. In fact, a majority of the studies reviewed either directly cite the ERS' findings or apply the ERS' methodology to their respective approach. Statistics Canada uses the ERS' methodologies and maintains similar databases on supply and disposition, food availability, and food availability adjusted for losses for specific commodity groups in Canada. Due to the ubiquity of the ERS' approach, this study uses the ERS' food loss percentages for fresh strawberries as the baseline for its estimations. These baseline loss percentages are subsequently adjusted to reflect context-specific factors affecting waste generation in Ontario's supply chain.

Source	Includes [I] or excludes [E] inedible food waste or undefined [U]	Geographic Area	Year of analysis	Absolute losses [A] or Losses relative to each stage [R]	Agricultural Production	Post-harvest handling & storage	Processing & packaging	Retail	Consumer	Overall
Fresh Fruits and Vegetables (unless otherwise stated)										
Gustavsson et al. (2011)	E	NA & Oceania	2007	A	20%	4%	2%	12%	28%	66%
Gustavsson et al. (2011) cited in Gunders (2012)	E (incl. processed)	NA & Oceania	n/d	R	20%	3%	1%	12%	28%	52%
Kader (2005)	U	Developed countries	n/d	R	2-23%			5-30%		7-53%
Kader & Rolle (2004)	U	Developed countries	n/d	A	12%			20%		33%
Mena et al. (2011)	U (incl.packaging)	Spain, UK	n/d	R	3-7%			–		–
Garnett (2006)	U (incl. processed)	UK	n/d	A	–	–	–	–	–	25%
Eriksson et al. (2012)	I	Sweden	2010	R	–	–	–	4.3%	–	–
Roberts (2012) cited in York Region (2012)	U	NA	2012	R	30%			–		–
Gooch et al. (2010)	U (measures unrecovered waste)	Canada	n/d	R	10-15%		10%	Transportation/Distribution = 2%	–	–
Kohn (2011)	U (measures shrink)	Ontario	2011	R	–	–	–	8-11%	–	–
Fresh Fruits: Losses from edible food supply										
Buzby et al. (2014)	E	USA	2010	R	–	–	–	12% / Total = 37%	25%	–
Buzby & Hyman (2012)	E	USA	2008	R	–	–	–	12% / Total = 30%	18%	–
Hodges et al. (2011)	E	USA	2008	R	–	–	–	14% / Total = 37%	23%	–
Gunders (2012)	U	USA	2005-2006	R	–	–	–	11%	–	–
Kantor et al. (1997)	E	USA	1995	R	–	–	–	2% / Total = 34%	30%	–
Fresh Strawberries										
Kader & Rolle (2004) cited in Garnett (2006)	U	Developed countries	n/d	A	23%			–	–	–
Terry et al. (2011)	I	UK	2009-2010	R	UK yield loss = 2-20% Central range loss = 2-3%	Grading loss = 1% Storage loss = 0.5%	Packing loss = 2-3%	2-4%	–	–
Warner et al. (2010) cited in Garnett (2006)	I	UK	n/d	R	10-30%	–	–	–	–	–
ERS (2014)	E	USA	2012	R	–	8% (from farmgate)		9.8%	35% 6.0% (Non-edible)	51%
ERS (2014); Buzby et al. (2009); Muth et al. (2011)	E	USA	Pre-2012	R	–	8% (from farmgate)		12.0%	20% 6.0% (Non-edible)	–
Peters et al. (2003)	I (excludes cooking loss)	New York State, USA	1994-1998	R	–	8% (from farmgate)		2%	30% 6.0% (Non-edible)	–
Wright & Billeter (1975)	I (Wholesale & retail), E (Consumer)	Chicago, USA	1966-1969	R	–	–	–	5.5%	22.2%	–
Gustavsson & Stage (2011)	I	Sweden	2008-2009	R	–	–	–	4.81% (Small stores = 6.47%, Large stores = 2.31%)	–	–
Roels, K. et al. (ND)	E	Flanders, Belgium	2010	R	2-10%			–	–	–
Other										
Gooch et al. (2010)	I (measures % of waste created by activities)	Canada	n/d	A	Field = 9%	–	Packaging/Processing = 18% Distribution = 3%	Retail Stores = 11% Food Service/HRI = 8%	Home = 51%	–

Table 7: Comparison of relevant studies on food loss and food waste in fresh fruit and vegetable, fresh fruit, and fresh strawberry supply chains. Information on geographic area, year of analysis, and other classifications are provided.

While patterns emerge within each stage of the supply chain, actors can also have different experiences regarding waste. Depending on factors such as type and size of their operation, location, demographic, and more, actors may be impacted by different causes and as a result they may be more or less susceptible to waste generation. Evidence of these differences can be found throughout the entirety of this paper. Based on these individual experiences, actors may also differ in what they believe will be the most effective approach for reducing food waste throughout the whole chain. Thus, a theme emerges in this study that highlights why it might be difficult to promote cooperation among chain actors and why it is difficult proposing solutions that will be widely accepted by a range of actors.

5.2. Total supply of domestically grown strawberries remaining in Ontario

In order to analyze food waste along Ontario's fresh strawberry supply chain, it is first necessary to determine the total supply of domestic strawberries at the beginning of the study period. Total domestic supply is calculated by subtracting the outflow of strawberries (exports) from the total inflow (marketed production plus beginning stocks). As fresh strawberries cannot be stored over long periods, beginning stocks are negligible. The average annual total supply of Ontario-grown strawberries remaining in the province between 2008 and 2012 is 5,642,861 kilograms; a breakdown of values is summarized in Table 8, below.

	2008	2009	2010	2011	2012	5-year average
Marketed production (kg)	6,260,000	6,211,000	5,857,000	4,731,000	5,178,000	5,647,400
Exports (kg)	768	10,186	8188	780	2,774	4,539
Total remaining supply (kg)	6,259,232	6,200,814	5,848,812	4,730,220	5,175,226	5,642,861

Table 8: Annual marketed production, exports, and total remaining supply of fresh strawberries in Ontario, 2008-2012.
Adapted from: Statistics Canada, 2014a; Statistics Canada 2014b.

5.3. Pre-harvest losses

This study includes an estimate for pre-harvest losses, which refer to unharvested strawberries on farms that are left in the field to be eventually plowed under. A majority of studies, including those conducted by the ERS and Statistics Canada, do not include pre-

harvest losses in their analyses. However, among relevant studies, the percentage range of pre-harvest losses was 2-30%. For example, a survey of British strawberry growers in 2006 found that 5-30% of their crop, or an average of 16 percent, were downgraded and nearly all were left in the field to rot (Stuart, 2009). Another strawberry farmer, this time in the US, found that after tracking waste on his farm that 20% of his crop was left in the field (Hirsch & Harmanci, 2013). Similarly, two Ontario strawberry growers, one large-scale and one small-scale, both estimated that 20% of their crops are wasted (S. Richards, personal communication, May 31, 2014; M. Whittamore, personal communication, May 7, 2014). When accounting for the range of pre-harvest losses found in the literature, this study estimates that the loss percentage for edible, but unharvested strawberries in Ontario is approximately 15%. Marketed production values are only in reference to strawberries that leave the farm and do not include the amount of unharvested strawberries. Therefore, the amount of edible, fresh strawberries that are unharvested in Ontario each year is an average of 995.8 tonnes of strawberries between 2008 and 2012.

5.4. Post-harvest handling and distribution losses

Statistics Canada describes losses occurring during post-harvest handling and distribution as quantities removed during processing or that are lost in storage, but does not include losses at the retail level, in households, restaurants, or institutions (Statistics Canada, 2012d). Waste occurs during these stages due to cleaning, weighing, culling, cutting, water evaporation, physical damage during transport, and more (Parfitt et al., 2010). The ERS refers to these losses as occurring at the primary level, which can be calculated by taking the difference between a commodity's primary weight at farm gate to its secondary weight when it arrives at retail, or its retail-weight equivalent (ERS, 2014).

Within the literature, the percentage range for losses occurring during post-harvest and distribution for fresh strawberries is as low as 2% (Roels, Vangeyte, Van linden & Van Gijseghem, 2012) to as high as 23% (Kader & Rolle, 2004). The ERS and Statistics Canada estimate an 8% loss percentage occurring at the primary level for fresh strawberries (ERS, 2014; Statistics Canada, 2012d). Terry et al. (2011) examine retail and wholesale supply chains for both imported and domestic fresh strawberries in the UK. The consolidated nature of the UK's fresh strawberry supply chains is strikingly similar to Ontario's, which

makes it useful for extrapolation. After consulting with three suppliers that collectively control 75% of market share for fresh strawberries in the UK, they estimate losses during post-harvest handling and distribution as grading loss (1%), storage loss (0.5%) and packaging loss (2-3%). Taken together, their estimate for percentage loss during post-harvest handling and transportation is 3.4 to 4.4 %.

In addition to primary level loss as described above, there is a small amount of strawberries that are removed from the fresh market and used in manufacturing and other industrial uses. The ERS does not provide information on the volume of strawberries removed from the fresh strawberry supply chain to be used in manufacturing, however, Statistics Canada accounts for this value. Statistics Canada does not provide comparable data for Ontario, so the five-year average (2008 to 2012) for the volume of strawberries removed from the fresh supply chain to manufacturing was calculated as a percentage of marketed production for Canada and applied to Ontario's values (Statistics Canada, 2012d). The average percentage of fresh strawberries removed from the fresh supply chain to be used in manufacturing in Canada between 2008 and 2012 is 6.1%.

The major food waste studies examining fresh strawberries (ERS, Statistics Canada, WRAP UK) include both imported and domestically grown strawberries in their estimations. It is likely that due to varietal selection that Ontario-grown strawberries are more susceptible to physical damage and spoilage compared to imported strawberries. As such, the loss percentages estimated in the literature for post-harvest handling and transportation are conservative. Given the range of loss percentages and the consideration for manufacturing loss, this study estimates that the percentage of Ontario's fresh strawberries that are lost or wasted during post-harvest handling and distribution is 11%, which is the equivalent to an annual average of 620.7 tonnes between 2008 and 2012.

5.5. Food retail losses

Losses at retail include losses in supermarkets, supercenters, convenience stores, mom-and-pop grocery stores and other retail outlets. Restaurants and other foodservice outlets are not included (ERS, 2014). Within the literature, the loss percentages occurring at the retail stage are between 2% (Peters, Bills, Wilkins & Smith, 2003; Terry et al., 2011) and 12% (Gustavsson et al., 2011). The upper range of 12% is used by many studies and is

taken from the ERS, however, it is important to note that the ERS has since updated its retail loss percentage. In 2009, the ERS updated its retail level food loss percentage for fresh strawberries from 12% to 9.8%. This change acknowledged that previous assumptions were too simplistic. For example, the 12% retail level food loss percentage was applied unilaterally for every fresh fruit and vegetable commodity in the database. Now, more precise estimates for each fresh commodity are used that better reflect physical differences in spoilage rates and other reasons that influence food loss, such as use of innovative packaging to prolong shelf life (Buzby, Wells, Axtman & Mickey, 2009). The ERS obtains its food loss estimates at the retail/institutional level to the consumer level from studies conducted by the Perishables Group, Inc. (PG). Loss percentages for individual commodities are estimated by comparing supplier shipment data with point-of-sale data from stores in large, national supermarket retail chains; research was also supplemented with qualitative information from retail contacts (*ibid*).

At this stage, there are likely differences in waste generation between imported and domestic strawberries owing again to varietal selection and to the difficulty of local berries moving through the centralized dominant retailer system (McCallum, Campbell & MacRae, 2014). However, the resulting losses for domestic strawberries due to the latter cause are not generally included in retailer stage loss estimates. As this paper will discuss later, due to the power of food retailers over their suppliers, these corresponding losses are pushed onto the producer stage. Evidence also shows that the amount of waste produced by food retailers varies between outlet types, with smaller grocery stores producing proportionately more waste than larger supermarkets. Consumers tend to use smaller stores for top-up shopping, making demand unpredictable. Because smaller grocery stores also lack sophisticated forecasting systems, waste is likely to be higher compared to larger grocery stores (Parfitt et al., 2010).

On average, this study estimates that 10% of edible fresh strawberries are wasted at the retail level in Ontario. This also confirms the observations by Kohn (2011) that the average supermarket shrink for fresh produce is between 8-11%. As such, this study estimates that the average annual amount of fresh Ontario strawberries that is wasted in food retail is 502.2 tonnes between 2008 and 2012.

5.6. Consumer level losses

Losses at the consumer level include food consumed at home and away from home; losses occurring from restaurants, fast food outlets, and other food services are included. These losses occur in storage, preparation and cooking of the food, as well plate loss, which is the food that makes it to the plate but is not consumed (Statistics Canada, 2014d). Losses at the consumer level are comprised of nonedible and edible shares of food; this study focuses on the latter category (ERS, 2014). The two most prominent studies on household food waste are conducted by WRAP UK and the ERS. WRAP UK carries out periodic updates on household food and drink waste in the UK. The most recent study, conducted in 2012, found that UK households threw out a total of 51,000 tonnes of fresh soft/berry fruit, of which 44,000 tonnes were avoidable food waste. This amounts to 1.67 kilograms of avoidable fresh soft/berry fruit being thrown out by each household in 2012 (Quested, Ingle & Parry, 2013b). WRAP UK's study only compares household food waste volumes against household food purchasing data for ten key commodities; fresh strawberries are not included in this comparison. As a result, the relative percentage of consumer level food loss for fresh strawberries is unavailable.

The ERS (2014) provides the most comprehensive and widely used consumer level food loss estimates for fresh strawberries. The ERS includes both imported and domestic strawberries in its estimates, which are calculated by subtracting food consumption estimates from food purchase or availability estimates. These calculations are then adjusted based on information from an expert panel experienced in analyzing food consumption data. Data on the nonedible share are taken from the National Nutrient Database for Standard Reference, compiled by the USDA's Agricultural Research Service (*ibid*). In 2012, the ERS updated its estimates for the edible share of consumer level loss for fresh strawberries from 20% to 35%. This percentage change reflects updated food consumption data from the National Health and Nutrition Examination Survey (NHANES) and updated food purchase data from Nielsen Homescan (Muth, Karns, Nielsen, Buzby & Wells, 2011).

This study follows the ERS and estimates that the edible share of consumer level food loss for Ontario fresh strawberries is 35%, which is equivalent to an average annual loss of 1,582.0 tonnes of fresh strawberries between 2008 and 2012. This estimate is also

comparable to a recent report by Statistics Canada that found only 71% of the calories that Canadians purchased were consumed, with the remainder (29%) being wasted (Statistics Canada, 2012b). Although the ERS' consumer waste estimates are based on both imported and domestic strawberry data, this study still chooses to apply their estimates to Ontario strawberries exclusively. This is not deemed problematic, as there have been no studies or anecdotal evidence that suggest consumer waste behaviours change according to the source of a food product. However, several other factors may affect levels of waste generation. Several studies have correlated the amount of food waste with a household's size, composition, demographic income, and culture. Smaller households, especially single-person households, waste more per capita than larger households. Households with children also tend to waste more than households with no children, although rates vary depending on the children's ages. Additionally, young people waste more than older people, with pensioners wasting the least (Parfitt et al., 2010). Silvennoinen et al. (2012) also report that the amount of food waste is positively correlated with appreciation of low prices and a respondent's opinion of the potential to reduce food waste within one's household.

5.7. Summary

When including pre-harvest losses, the overall percentage of edible waste occurring along Ontario's fresh strawberry supply chain is 56%, which is equivalent to an average of 3700.5 tonnes of strawberries being wasted each year between 2008 and 2012. For each stage of the supply chain, the percentages of strawberries wasted are as follows: 15% during agricultural production; 11% during post-harvest handling and distribution; 9% during retail; and 35% during consumption. Consumers are the largest contributors to strawberry waste generation and are responsible for 43% of all strawberry waste generated in the chain. Agricultural production, mainly losses during pre-harvest, are the second largest contributor to strawberry waste generation (27%), followed by post-harvest handling and distribution (17%), and lastly retail (13%).

SECTION 6: CAUSES OF FOOD WASTE IN THE SUPPLY CHAIN

After consulting with chain actors and relevant literature, this study clusters the main causes of food waste in Ontario's domestic fresh strawberry chain into biophysical factors; technical factors; issues of mismanagement; regulatory factors; behavioural factors; and the dynamics of supplier-retailer relationships. However, in recognizing the fluidity of supply chains, chain actors, and the internal and external factors that affect these chains, the following causes are not necessarily attributed to any particular stage of the supply chain.

6.1. Biophysical Factors

Biophysical factors arising from natural phenomena are significant causes for waste in Ontario's fresh strawberry supply chain. Biophysical factors include weather, pests, disease, and pathogens. In fact, all producer respondents in this study noted biophysical factors as the most significant contributors to food waste in their operations. Strawberries are especially susceptible to physical damage and spoilage due to their fragility and short shelf life (Terry et al., 2011).

6.1.1. Weather

Due to their precise growing requirements, changing weather conditions greatly affect not only the physical development of strawberries, but also consumer demand. High temperatures accelerate strawberry maturation by decreasing the time between flowering and harvest. If this excess supply does not match demand, edible strawberries may be left in the field. Wet weather also causes waste, as higher humidity levels lead to softer fruit (Terry et al., 2011). According to Mike Whittamore, owner of Whittamore Farms in Markham, Ontario, if there is too much rain, the quality of his strawberries is poor and he must leave them on the ground (M. Whittamore, personal communication, May 7, 2014). Similarly, Roger Knapp, a Guelph-area grower, lost nine acres of strawberries to wet weather in one season (Dharmarajah, 2011). Cold weather can also cause waste as strawberries are frosted out, however, this is rare (M. Whittamore, personal communication, May 7, 2014).

Immediate weather conditions also greatly impact waste generation, as it shapes short-term supply and consumption trends. Demand for domestic strawberries typically triples between the start of the season and the main harvest period in June. When temperatures are stable for an extended period, sales are more predictable and producers are able to forecast appropriately. If weather conditions fluctuate, however, producers may not be able to respond quickly enough, resulting in waste. Short-term consumer demand for fresh strawberries can increase to as much as 40% in periods of high temperatures (Terry et al., 2011). Losses due to weather fluctuations occur across all sizes of farms, however, the associated reasons for waste differ based on intended retail channels. For farms that supply wholesalers and distributors, an increase in temperatures causes oversupply, as many producers rush to bring their strawberries to the market. As a result of oversupply in the market, prices are pushed downward and cause some growers to leave excess strawberries in the field (M. Whittamore, personal communication, May 7, 2014). For farms that sell directly to consumers, such as U-Pick operations, extremely hot temperatures cause less people to visit strawberry farms. Because strawberries are not being picked quickly enough, they ripen and are left to rot in the field (small-scale producer, personal communication, May 7, 2014).

6.1.2. Pests, disease, and pathogens

Another biophysical cause for food waste is the occurrence of pests, disease, and pathogens. Pests, such as the Spotted Wing Drosophilia (SWD), have recently invaded most fruit growing regions in North America. Spotted Wing Drosophilia lay eggs in fruit as it is ripening causing fruit to lose its integrity and break down earlier. Late-season day-neutral strawberries are especially susceptible to SWD (Ontario Berry Grower, 2013). Pathogens such as *Botrytis cinerea* (grey mould) and *Rhizopus stolonifer* (leak rot) also cause disease in strawberries (Terry et al., 2011), which can accelerate spoilage or cause blemishes on berries (S. Richards, personal communication, May 31, 2014). Because strawberry plants reproduce via cloned daughter plants, diseases spread easily. Accordingly, if the original strawberry plant is susceptible to a disease, subsequent daughter plants will suffer the same fate (Porter, 2009). Ontario's Ministry of Agriculture, Food and Rural Affairs encourages its strawberry producers to start new plantings with material grown under a

certified or accredited plant propagation system to reduce the potential to spread disease into new planting material (Gardner et al., 2006). Sprays can also be used to minimize certain pathogens, however, these may not be viable for all growers. For example, grey mould problems are the biggest cause of waste at Levendale Farms, but as owner Selene Richards notes, there are no effective sprays available for organic growers (S. Richards, personal communication, May 31, 2014). Entire fields of strawberries may also be wasted if they do not comply with minimum food safety standards. Food can be considered unsafe for a variety of reasons, such as naturally occurring toxins in the food itself, unsafe use of pesticides, contaminated water, and more (Gustavsson et al., 2011). For example, strawberries can be contaminated by the single-celled parasites *Cryptosporidium* and *Giardia*, which cause diarrheal disease. These parasites cannot be killed using typical post-harvest sanitizing processes nor does washing remove all cysts (Ontario Berry Grower, 2013). More serious *E. coli* infections are also possible, with one recent case of *E. coli*-infected strawberries grown in Oregon, US linked to at least fourteen infections, including one death (FDA, 2011).

6.2. Technical factors

Technical factors contributing to waste refer to inefficiencies, breakdowns, or a lack of access to equipment and markets. Actors experience different levels of losses due to technical factors depending on their economic status, location, sociocultural belief, and more. For example, access to capital and other resources determines whether an actor is able to upgrade or purchase equipment. Economic limitations explain why smaller-scale growers and retailers tend to experience more losses relative to larger-scale actors (Gustavsson & Stage, 2011). Also, actors that are located farther from distribution centres and markets must transport strawberries over longer distances, creating more chances for breakdowns to occur. Farther distances may also limit access to markets if actors cannot justify the costs of transportation (McCallum et al., 2014). Additionally, even if certain practices are inefficient, some actors may choose not to change due to sociocultural beliefs (Gooch et al., 2010). This paper identifies cold chain management, lack of storage capacity, packaging, and inaccessible markets as the main technical factors contributing to waste.

6.2.1. Cold chain management

Inefficiencies or breakdowns in equipment can compromise the cold chain, leading to strawberries being wasted. Correct temperature management is vital in preventing strawberry waste. Harvested strawberries must be quickly cooled and then maintained at 4-8 degrees Celsius during retail (Terry et al., 2011). Producers must quickly remove field heat from strawberries once they are harvested. For every hour delay before cooling there is a corresponding loss of about 10% of strawberries at the retail level. Unfortunately, many Ontario strawberry farms use less efficient walk-in coolers, which can take days to cool strawberries. In contrast, sophisticated forced-air cooling can cool strawberries in a matter of hours (Porter, 2009). Many of Ontario's small-scale producers do not have the necessary capital to purchase expensive forced-air cooling equipment, leaving no other option than to continue using less efficient equipment (McCallum et al., 2014). The importance of cooling greatly impacts shelf life. Scientists in California have found that strawberries kept at 2 degrees Celsius will last 10 days instead of hours (Porter, 2009). Yet, many retailers do not cool strawberries in display. This may also be related to economic limitations or can stem from a lack of understanding by store managers on proper temperature management and product display (Terry et al., 2011). Inconsistent refrigeration along the cold chain can lead to spoilage, however, breakdowns in refrigeration equipment is rare (Gunders, 2012; Mena, Adenso-Diaz & Yurt, 2011).

6.2.2. Lack of storage capacity

A lack of storage capacity for producers and retailers may also contribute to waste generation. During bumper crop years when there is a glut in supply, farmers either lack short-term storage space or they may over pack coolers, which reduces the efficiency of cooling mechanisms (Terry et al., 2011). Also, as initial inspections are done in the fields, growers may choose to leave sub-grade fruit behind if they lack capacity at their packing house (Kohn, 2011). Similarly, retailers who lack chill capacity at back of store and on-shelf cannot always cope with increased volumes. As a result, the risk of spoilage increases as ambient shelf space is used to display berries (Terry et al., 2011).

6.2.3. Packaging

Packaging both prevents and contributes to strawberry waste. Given the fragility of strawberries, packaging can reduce the amount of waste by physically protecting strawberries from damage, reducing excessive handling, and delaying decay (Kohn, 2011). If strawberries are transferred directly from the field to a package, known as a "one-punnet" system, this significantly reduces handling, which in turn reduces waste (Terry et al., 2011). However, packaging can also contribute to strawberry waste in a number of ways. If standard pack sizes are too large, stores may end up ordering more than they expect to sell (Gunders, 2012). Other times, logistics surrounding labeling limit a retailer's actions. A package of strawberries with one less fruit will not be the same weight as that advertised on the label (Terry et al., 2011). Packaging also acts as a perverse incentive to waste by making it cheaper to dispose of strawberries compared with sorting through and saving good ones. De-packing is labour intensive, so if one fruit is damaged in a pack of strawberries, the whole pack is considered bad and as a result it is thrown out (Kohn, 2011).

6.2.4. Inaccessible markets

Strawberries are often wasted or unharvested if producers lack the time or ability to sell to markets; other times it is not profitable to do so. The primary market for fresh strawberries is through retail, whether it is direct to consumers or sold in supermarkets. Ontario's leading supermarket chains operate their own distribution centres, which has significantly limited access for smaller scale producers to local stores. Before the advent of grocery distribution centres, farmers could easily arrange to make direct deliveries to local stores. Since then, smaller producers are finding it harder to access shelf-space in supermarkets. One reason for this is that some producers are unable to meet the large volume orders desired by distribution centres. Additionally, many chain stores have stopped receiving direct deliveries because it is easier to deal with one large supplier, instead of many smaller growers (Ottawa Citizen, 2007). According to Peter Streef, vice-president of Streef Produce Ltd., a wholesaler that delivers to the three largest grocery chains, "Chain stores are so big, they don't want to have 50 small producers at the door delivering an inconsistent product. They're obviously looking for the larger volume

producers that can bring them continuity of supply" (Porter, 2007). Some stores still accept direct deliveries, however, this is exceedingly rare. In 2012, Les Murphy, owner of a farm in Binbrook, Ontario, was able to establish an agreement with a local Longo's supermarket to directly supply strawberries to the store (York Region, 2012).

Producers use secondary markets to find additional buyers when there is excess supply. Excess supply may result from a variety of circumstances, including overproduction, when a retailer cancels a pre-existing contract, or when a buyer rejects a shipment. Due to the power of retailers over their suppliers, retailers are able to offload liability of rejected shipments onto small producers, forcing producers to find alternate markets. Supplier-retailer relationships are a significant cause for food waste in the supply chain and will be revisited later in this paper. For growers, finding additional markets must be done quickly to avoid spoilage, especially if they lack appropriate storage facilities (Kohn, 2011). By the time a shipment is rejected by an initial buyer, which may not even be based on legitimate reasons, its contents have a shorter shelf life (Gunders, 2012). Unfortunately, producers struggle to access secondary markets with many buyers insisting on products with at least 70-90% of their shelf life still available, which is problematic for strawberries (Kohn, 2011). Because there is no guarantee of securing a buyer, producers may leave strawberries unharvested, as picking the fruit would result in greater loss further down the supply chain (Terry et al., 2011).

Alternately, producers may try to sell to tertiary markets, such as canning and jam processing. Finding a processing facility that will agree to take excess produce on short notice is difficult, as processor contracts are usually drawn up in advance (Kohn, 2011). Additionally, the processing facility must also have the capacity to process strawberries (Gunders, 2012). Other times, facilities may require strawberries meet specific attributes amenable to processing (Terry et al., 2011). If producers cannot find a tertiary market, they may attempt to further downgrade or discount their product to find lesser value markets (Gooch et al., 2010). Even if a producer is able to access appropriate markets, they may still choose to leave strawberries unharvested if an agreement is not profitable. The prices offered in the processing sector are much lower than those found in retail markets (Gustavsson et al., 2011). For example, the Agricultural Credit Corporation's 2014-2015 advance price for fresh strawberries in Ontario is $0.86 per pound, while the advance price

for processed strawberries is $0.27 per pound (ACC, 2014). Labour remains one of the highest costs for producers, as each strawberry must be harvested by hand. If processing prices are not competitive, it may not warrant the labour and transportation costs required to bring it to market. Other times, growers may choose to delay bringing harvested crops to market based on the demand, prices and market cycle. While there is some risk for spoilage during storage, growers may still choose to delay selling in hopes of higher market prices (Gunders, 2012). However, as noted above, this may not always be an option if growers lack appropriate storage facilities (Kohn, 2011).

6.3. Mismanagement

Management, or rather mismanagement, leads to unnecessary inventories, unnecessary handling, excessive delays, and long lead times, all of which contribute to food waste (Mena et al., 2011). Examples of mismanagement include inaccurate or unnecessary forecasting, convenience foods, insufficient employee education, labour restrictions, and a lack of commitment by supply chain actors. The common use of price promotions by food retailers is another symptom of mismanagement.

6.3.1. Inaccurate and unnecessary forecasting

Planning and forecasting errors are significant contributors to strawberry food waste in Ontario. Forecasting systems ensure supermarkets are properly stocked according to the unique needs of customers living in each area (Silvennoinen et al., 2012). Consistent forecasting also assists growers with producing appropriate amounts of products (Terry et al., 2011). The dominant supermarket chains in Ontario all use sophisticated predictive and logistic systems for handling orders. Smaller, independent food retail outlets likely do not have the same resources and thus employ more informal methods to forecast demand (Mena et al., 2011). However, even with the most sophisticated predictive systems a degree of uncertainty will continue to exist and forecasting errors will still occur. Estimating the demand for a product is complex and inherently difficult. Unforeseen circumstances related to weather, seasonality, marketing campaigns, product launches, promotions, and special occasions all affect demand (Gunders, 2012). Other times, companies will buy according to low prices in the international markets instead of according to final demand (Mena et al.,

2011). Kohn (2011) notes that despite computerized ordering systems and advanced forecasting mechanisms, many supermarkets still do not plan well to order the amount of food they actually need. Many supermarkets do spot ordering, which results in high fluctuations in orders; unnecessary inventories must either be discounted or taken as a loss. Additionally, if deliveries sit too long on the loading dock, a shipment of strawberries can spoil from lack of refrigeration (Gunders, 2012). Given the short shelf life of strawberries, there is little room for error in forecasting and ordering.

Waste also occurs not as a matter of poor forecasting, but unnecessary demand forecasting by supermarkets (Kohn, 2011). It is quite common in North American retail stores to create waste by having displays of fresh food far in excess of their sales (Hodges et al., 2011). The perception of abundance is believed to be attractive to consumers, leading to increased sales (Gunders, 2012). Similarly, over ordering is driven by the fear of not meeting consumer demand. Industry executives believe that some losses from over stocking are acceptable; as they will be offset by gains from attracting customers with abundantly stocked shelves (Kohn, 2011; Stuart, 2009). In addition to abundance, consumers also desire the appearance of newly stocked items. However, constant stock rotation promotes waste if discerning consumers favour newly stocked strawberries over those that are close to expiry (Gustavvson et al., 2011). Overstocking can also lead to over handling by both staff and customers, which may damage items and generate more waste (Gunders, 2012).

6.3.2. Convenience foods

An increase in prepared foods has increased waste. Ready-made foods can be a good way to use marginally damaged or nearly expired products if the labour is available to do so; however, this practice is not the norm among store managers (Kohn, 2011). Like fresh produce, managers feel compelled to maintain displays of fully stocked, ready-made foods made only with the freshest ingredients (Gunders, 2012). Supermarkets managers argue that a majority of their consumers would be unhappy to know that bruised or imperfect strawberries were used to make ready-made meals. As a result, fresh strawberries intended to be used as ingredients become part of store food orders, rather than being sourced from existing inventories of slightly damaged produce. As Kohn (2011) notes, the

rationale used by supermarkets to justify this practice seems baseless. Most times, consumers do not even ask about the origins of ingredients and if they do, supermarkets can simply say they use food from their stores rather than labeling it as culled. A significant amount of waste occurs due to slightly damaged or subgrade strawberries being passed over as ingredients by store managers. Waste also occurs when the desire for fully stocked displays results in a number of unsold ready-made meals at the end of the day (Gunders, 2012). Unfortunately, ready-made meals must be thrown out as health codes prevent food from self-serve bars from being donated, repurposed, or packaged for sale (Kohn, 2011).

6.3.3. Insufficient employee education

Insufficient employee education regarding food waste reduction strategies and standard operating procedures contributes to waste generation along the supply chain. During agricultural production, poor handling at harvest can lead to loss (Terry et al., 2011). At the retail and food service stage, poor employee education on proper stacking, shelving, stock rotation, food preparation, and waste disposal can all lead to increased waste. Food may also be wasted due to staff behaviour and kitchen culture (Gunders, 2012). Part of the reason for insufficient employee knowledge is the increased labour costs required to train them. In particular, supermarkets with high turnover rates or with a high number of part-time workers may not want to invest in additional employee training (Kohn, 2011). Employees working closer to a physical product are less attentive to waste prevention if they are unaware of stock levels or how their handling affects the amount of waste generated. Food waste resulting from insufficient employee education is exacerbated if there is no specific role within a company focusing on waste. Supermarkets that have poorly defined waste management responsibilities do not usually measure or manage their waste systematically (Mena et al., 2011).

6.3.4. Labour restrictions

Perfectly edible food may be wasted due to labour restrictions, such as labour shortages and the high costs of labour. Labor shortages may contribute to waste at both the production and retail stage of the supply chain. During agricultural production, labour shortages lead to lower harvest rates, especially when harvest timing is critical. As a result,

a large number of perfectly edible crops may be left in the fields unpicked. At food retail, with low staffing levels there is less labour to prepare food on-site and therefore less flexibility in repurposing minimally damaged products (Gunders, 2012). Food may also be wasted if the time and labour costs needed to de-package and salvage strawberries do not justify the benefit of reducing this amount of waste (Kohn, 2011).

6.3.5. Lack of commitment along chain

There is a noted lack of commitment by supply chain actors to communicate with each other effectively in order to reduce waste within the chain (Gooch et al, 2010). In a competitive industry based on cost, efficiency, and availability, waste is not usually considered a key performance indicator. In some cases, the current food system model allows for a degree of acceptable waste (Mena et al., 2011). Due to the complexity surrounding the causes and occurrence of food waste, there is a tendency for actors to blame each other for problems, rather than seek collaborative solutions (Gooch et al., 2010). Additionally, the costs to tackle food waste may be borne in one stage of the supply chain, whereas the benefits may occur in another stage; or, the costs may occur upfront, with the benefits, if any, occurring later. For example, farmers may seek to reduce food losses by improving their storage facilities; however, if they do not have adequate market access or receive competitive pricing for their additional crop, it may not be worth their effort if initial investments cannot be recuperated (Rutten, 2013). Accurate and timely information is essential for improving planning and forecasting. Variations between forecasting and orders increase when there is lack of communication; these variations can amplify across the supply chain leading to unnecessary waste (Mena et al., 2011). Many companies choose not to share information regarding their waste audits and forecasting methods because they do not want their competitors to gain an advantage (Kohn, 2011). The lack of information sharing not only contributes to waste generation, but also undermines the confidence of chain actors when information is provided (Mena et al., 2011).

For supermarkets and other food retail, service efficiency is prioritized over efforts to reduce waste (Mena et al., 2011). Profit margins in food retail are so tight that every aspect of operations is meant to eliminate waste, or shrink, as much as possible. However,

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reducing shrink is considered to be profitable only to a certain extent, as there is still a need to maintain high sales (Kohn, 2011). According to a former Sobey's executive, if stores only concentrate on reducing shrink, they end up with empty shelves, which may negatively impact a store's sales (*ibid*). A former president of Trader Joe's also reflects this sentiment; he states,

> The reality as a regional grocery manager is, if you see a store that has really low waste in its perishables, you are worried. If a store has low waste numbers it can be a sign that they aren't fully in stock and that the customer experience is suffering. (Gunders, 2012, p.10)

In this sense, waste is just a part of doing business in the food retail landscape. In fact, an appropriate amount of waste is a sign that a store is meeting quality control and full-shelf standards, meaning that blemished items are removed and shelves remain fully stocked (Gunders, 2012). Supermarket chains have standard operating procedures and practices for their stores and are wary of implementing any change, which may not prove economical (Kohn, 2011). From the perspective of costs and benefits, it is better for some food loss to occur at a relatively low cost, rather than take measures at a relatively high cost to combat them (Rutten, 2013). At the food retail and food service stages, individual store or restaurant managers may want to creatively make use of unnecessary inventory, but are prevented from doing so because of rigid company policies (Gunders, 2012).

6.3.6. Price promotions

A proportion of consumer waste is partly a result of management decisions by supermarkets to take advantage of consumers' desire for value (Gooch et al., 2010). Price promotions can be helpful in reducing waste by assisting supermarkets and suppliers with removing gluts during times of high availability (Terry et al., 2011). However, price promotions can also lead to increased waste if they regularly encourage consumers to purchase beyond their needs, especially for items with short shelf lives, like strawberries (Kohn, 2011). Canadian retailers rely heavily on price-oriented flyers as a primary marketing strategy for driving footfall and sales (Gooch et al., 2010). Figure 11 showcases a sample of grocery flyers in Ontario, all featuring price promotions on fresh strawberries. For some stores, consumers are required to purchase three packs of strawberries in order

to receive the advertised discount. In other cases, the strawberries on sale are only sold in larger, two-pound packs. As a result of these promotions, consumers overly prioritize price and buying in bulk, rather than purchasing for their needs (Gooch et al., 2010).

Figure 11: A sample of Ontario grocery flyers featuring price promotions on fresh strawberries.
Photo credit: Food Basics, 2014; Walmart, 2014; Metro, 2014; Loblaws, 2014.

Promotions also create unpredictable demand patterns, driving demand to as much as an additional 50 percent (Terry et al., 2011). Promotions not only create unpredictable demand for the products being promoted, but also for products that are not on sale. Through the process of cannibalization, consumers ignore items that are not on sale, which may lead to those items being wasted (Mena et al., 2011). Strawberry producers are vulnerable to sudden order changes, as growing and harvesting cannot be suspended. Conversely, retailers may not be flexible to turn promotions quickly enough to respond to surpluses. As such, unpredictable demand patterns lead to less accurate forecasting and ordering, which further increases overproduction and waste (Terry et al., 2011).

6.4. Regulatory factors

6.4.1. Government grading standards

Regulatory factors, such as government grading standards, have been hypothesized as having an impact on waste generation; however, supply chain actors did not perceive this to be true. Data on waste generated on farms are not systematically collected by Statistics Canada or other research organizations. Consequently, examining changes in the

generation of food waste before and after the removal of provincial grading standards must be based primarily on interviews with key actors. Accordingly, the recent removal of Ontario's grading standards was perceived by actors as not having had any significant effect on the generation of waste within their operation, whether positive or negative. The main reason why government grading standards are not considered significant to waste generation is because consumers and retailers continue to impose much more stringent food quality standards. Selene Richards, owner of Levendale Farms notes,

> We never sell anything that is blemished (or) of poor quality, whether there are standards or not. We are competing in a highly competitive community supported agriculture and farmers market environment and if our products are not perfect, we would easily lose customers to someone else…Our grading standards remain the same whether there are regulations or not. (S. Richards, personal communication, May 31, 2014)

Other times, providing only high quality produce is a matter of personal pride. Brian Gillroy, former president of the Ontario Fruit and Vegetable Growers Association (OFVGA) says, "A farmer is very proud of his produce. They would only want the very best out there if it has their name on it" (Lowe, 2011).

Supermarkets also set high food quality standards above those set by federal regulation in order to compete for the attention of customers in Ontario's highly concentrated food retail landscape (Kohn, 2011). Accordingly, supermarkets are compelled to only have produce of perfect shape, size, and colour (Gunders, 2012). According to Eric Biddiscombe, Senior Director of Planning for Loblaw Companies Limited (LCL), federal regulations are viewed as a baseline in which to build higher internal standards. He states, "We don't accept those (government) standards because they're minimum standards. What we do is create our own quality standards, which we call quality specifications" (Kohn, 2011, p.41). In fact, LCL has a minimum of 850 quality specifications for its fruits and vegetables alone, ranging from sugar content, size, and colour. Maintaining high quality food standards not only promotes consistent best practice, but also allows supermarkets to remain competitive. Safety and quality standards are considered critical for building consumer confidence and maintaining loyalty (Kohn, 2011).

Therefore, the presence or absence of government grading standards has little to no effect on the day-to-day operations of chain actors and subsequent waste generation. As

long as consumers continue to demand high cosmetic standards for their produce, chain actors will also continue to set their own high food quality standards, above those set by governments, in order to meet consumer preferences.

6.4.2. Free trade agreements

Free trade agreements between Canada and the United States have indirectly contributed to waste generation, as local growers are unable to compete with the quantity and price of imports. Free trade agreements ideally stimulate economic activity between countries by removing barriers to trade; however, these benefits have clearly advantaged US fresh strawberry exporters over Ontario growers. The North American Free Trade Agreement (NAFTA) took effect in 1994 between the United States, Canada, and Mexico. In accordance with NAFTA, the earlier bilateral Canada-US Free Trade Agreement (CUSTA) took effect in 1989 providing for a phased elimination of most tariffs and non-tariff barriers to trade over a period of ten years. Before CUSTA, US fresh strawberry exports to Canada faced a tariff of 6.61 cents per kilogram. Similarly, U.S. tariffs on fresh strawberry imports from Canada were 0.4 cents per kilogram for the summer period (June 15 to September 15) and 1.7 cents per kilogram for the rest of the year. Beginning in 1989, bilateral tariffs were reduced over ten years and reached zero by January 1, 1998 (Brunke & Sumner, 2002). The impact of NAFTA and CUSTA on increasing the market share of California-grown strawberries can be seen in Chart 6.
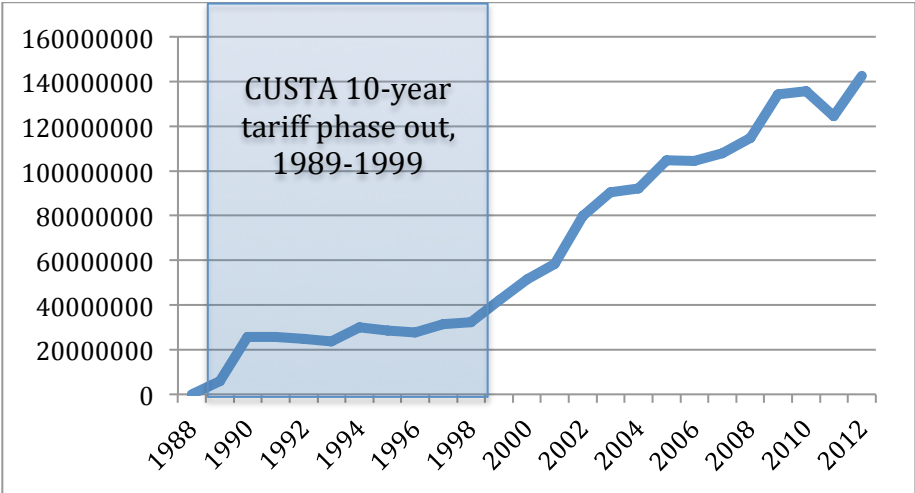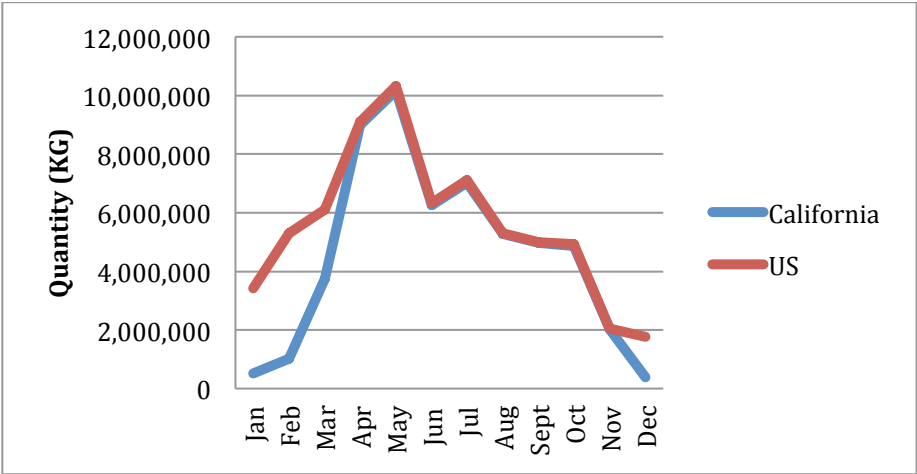

Chart 6: Value of fresh strawberry imports from California to Ontario (CAN$), 1988 to 2012.
Adapted from: Statistics Canada, 2014a.

Over the course of CUSTA's tariff reduction schedule, US exports of fresh strawberries from California to Ontario have increased seven-fold from $6 million in 1989 to $42 million in 1999. Since then, the dominance of California growers continues with the value of fresh strawberries imported to Ontario rising further to $142 million in 2012 (Statistics Canada, 2014a). Ontario now imports a majority of its fresh strawberry supply from the United States. Between 2008 and 2012, imported strawberries represented 92% of the total fresh strawberry supply in Ontario. In particular, the state of California accounted for 81% of the volume of imported fresh strawberries into Ontario (Statistics Canada, 2014a).

Due to Ontario's confined growing season, it is not possible to maintain year round supply of domestically grown strawberries. During the off-season, importing strawberries is a viable alternative that assists with meeting consumers' expectations of year round availability. Implicit agreements previously ensured that imported strawberries would primarily supply during off-seasons, leaving local production to primarily supply during peak season (Porter, 2007). However, this relationship has changed as strawberries are increasingly being imported, even at times when local production is at its height. Chart 7 shows the pattern of fresh strawberry imports from the United States and California in the sample year of 2012. Imports from the United States and California are the highest in the shoulder right before Ontario's peak season and remain high throughout the summer months.

Chart 7: Quantity of fresh strawberry imports to Ontario, 2012
Adapted from: Statistics Canada, 2014a.

This shift has been problematic, as Ontario growers cannot compete with the sheer size and volume of California's strawberry industry. With favourable year-round climates, California growers have significant advantages, producing over 130 times the volume of their Ontario counterparts. Compared to Ontario, California has larger-sized farms (20 hectares versus 4 hectares average) and benefits from higher yields (34,000 versus 2,000 kilograms per hectare). Because each farm shares similar overhead costs (i.e. property taxes, equipment, coolers, etc.), regardless if a farm is in California or Ontario, California growers who produce larger volumes of strawberries can offer significantly lower prices (Porter, 2007). Some Ontario growers even accuse California of using Ontario as a "dumping ground" for its berries (M. Whittamore, personal communication, May 7, 2014).

Ontario wholesalers and retailers are increasingly replacing local berries with cheaper imports, even when local production is at its peak. Rusty Smith, owner of Manitree Fruit Farm, notes that Ontario growers used to provide up to 90 percent of strawberries sold in grocery stores. Now, this has been reduced to "filling in shorts", which is only about 25 percent of the market (Shreve, 2011). Some local grocery stores make active efforts to source local berries during peak season, but this is fast becoming the exception, rather than the rule. Ivan Vandenenen, a worker in the produce department at Real Canadian Superstore, notes that his store tries to sell as much local produce as possible when it is in season. They order both from the warehouse, and when the local season comes in, they order right from the supplier (*ibid*). In Ontario, seventy-five to eighty percent of strawberries sold in Longo's stores in the summer are local (OBGA, 2014). At the national level, Walmart Canada has committed to increasing that availability of locally grown strawberries to 100% when it is in season by the end of 2013 (Lowe, 2011). Walmart's definition of local extends nationally, which does not necessarily provide a steady market for Ontario strawberry growers. There are also several logistical hurdles that prevent large food retailers from sourcing more local products, which primarily stem from the process of coordinating large numbers of smaller growers in order to meet the volume and quality specifications set by the company (McCallum et al., 2014). It is also unclear whether Walmart has succeeded in fulfilling its commitment as the company tightly guards supplier information.

Sometimes Ontario wholesalers and retailers shift completely towards imported strawberries with California berries being the exclusive choice. These decisions are partly driven by the need for Ontario buyers to maintain positive relationships with California importers who provide cheap prices. J.E. Russell Produce, a prominent fruit wholesaler in Toronto, buys only California berries, even at the peak of Ontario's season. It's vice-president, Tom Meschino, explains his company's choice, "The guy gives me strawberries all winter long and now I'm going to say I don't need them? We feel obligated to take them" (Porter, 2007). Similar import pressures can be found in Ontario's food processing and manufacturing industry. Assuming growers are able to secure advanced processing agreements, these agreements may still terminate if a company chooses to source lower priced imported goods (Kohn, 2011).

As previously noted, strawberry growers decide whether it is financially viable to sell their strawberries based on particular market conditions relating to price, demand, and accessibility to buyers. Many local strawberry growers cannot afford to sell their berries at prices that are comparable to imported strawberries. The prices paid for California strawberries are as low as $1 to $1.50 per pound, which are unrealistic according to the Ontario Berry Growers Association (Shreve, 2011). Eric Henneberg, owner of Fergus Farms, notes that matching import market pricing does not leave much for the grower, considering the container alone costs about 25 cents and there is the cost of picking and growing the strawberries. If he were to sell at the same price of imports, he would simply be broke. Another grower, Roger Knapp, could not lower his prices to match import prices, especially as he had to absorb losses due to bad weather. Left with no place to send unwanted produce, growers end up leaving perfectly edible strawberries on their fields. Knapp notes, "It is cheaper for us to let it rot in the field", as it costs more to pay people to pick the berries (Dharmarajah, 2011).

6.5. Behavioural factors

Consumers are considered the largest contributors to food waste along the supply chain, with more than half of all food that is wasted in Canada occurring within the home (Gooch et al., 2010). Based on consumer research of households in the UK, Australia, and

the United States, the following reasons have been identified as the main contributory factors to food being wasted in households (Figure 12).

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Main contributory factors to food being wasted in households

- o Poor pre-shop planning
- o In-store behaviour
- o Food date labels
- o Storing food correctly
- o Meal planning
- o Food management in the home
- o Portion control
- o Poor "home economics" skills

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Figure 12: The main contributory factors to food being wasted in households in the UK, Australia and the US.
Adapted from: Parfitt et al., 2010.

When examining fresh soft/berry fruit specifically, a study of UK households found that the main reasons for waste are: not used in time (86%); cooked, prepared or served too much (5%); personal preference (5%); accidents (2%); and other (2%) (Quested et al., 2013b). Research shows that household food waste is significantly driven by consumer behaviour, which can also generate waste elsewhere in the supply chain by shaping the behaviours and actions of upstream actors. However, the behaviours of individuals are themselves determined by the structure and operation of the agri-food sector, as well as other incentives, policies and processes (Gooch et al., 2010). Food industry executives deny that they deliberately shape consumer behaviours to their benefit and instead argue that they are simply responding to consumers' desires (MacRae et al., 2012). As discussed in further detail below, the relationship between consumers and the food industry is much more complex than the food industry asserts, which creates difficulties when proposing food waste strategies. This study applies the findings of past research to identify the following behavioural factors that cause consumers to waste fresh strawberries: intolerance for substandard produce; carelessness; and a lack of basic food knowledge.

6.5.1. Intolerance of substandard produce

      A significant pressure driving waste in the supply chain is growing consumer intolerance of substandard foods, cosmetic defects, and misshapen produce. Household waste is generated when consumers discard blemished, but still edible strawberries. Waste is also generated as upstream chain actors enforce unnecessarily high grading standards in order to satisfy consumer preferences (Hodges et al., 2011). Many customers select stores based on the quality of perishables; even a single negative experience can dissuade a customer from returning. According to a recent survey conducted by WRAP UK, 24 percent of consumers admitted that if they purchase berries from a store that end up deteriorating, they are less likely to buy berries from the same place again (Whitworth, 2013). Retailers did not always impose high food quality standards. A better range of products could be found; especially as discount retailers were not willing to pay for higher priced, higher quality products. However, the prevalence of boutique supermarkets offering flawless products, such as Whole Foods and Longo's, has helped drive up expectations of cosmetically perfect fruit. Now, even discount stores are requiring "high quality" foods in order to remain competitive (Kohn, 2011). In addition to cosmetically perfect produce, consumers also expect a wide range of products to be available in stores year round. They expect consistency regarding selection, price, availability, freshness, and their overall shopping experience (*ibid*). Even at closing time, consumers expect stores to offer fresh bread, prepared foods, and fully stocked produce sections (Silvennoinen et al., 2012). As expected, an overabundance of products will inevitably lead to some products not being sold by the time they spoil (Gustavsson et al., 2011).

      Consumer intolerance for substandard produce has reached its highest level, with no signs of decreasing. A recent report observed that if a consumer found two apples on a display that were slightly bruised or of lesser quality, they would associate the entire display with poor quality (Gooch et al., 2009). In a paradoxical chicken-or-egg scenario, it is difficult to determine if it is consumers or food retailers that are the root cause for unnecessary demand of cosmetically perfect produce. On one side, consumers prefer blemish-free produce, which compel supermarkets to provide only produce of perfect shape, size, and colour. On the other side, the prominence of perfect looking produce and the invisibility of perfectly edible, but blemished produce at supermarkets reinforce and

even amplify consumer demand. The positive feedback relationship between consumers and food retailers for cosmetically perfect produce has significant impacts on waste generation throughout the whole chain. Also, because it is unclear if consumers or the food industry are driving this demand, this presents challenges when proposing food waste strategies. As discussed in Section 6.3.5, actors tend to blame each other for problems (Gooch et al., 2010). The food industry benefits from deflecting the responsibility of food waste onto consumers, as subsequent waste strategies and their associated costs are pushed onto other actors.

6.5.2. Carelessness

The low cost of food and the relative invisibility of food waste has promoted careless attitudes and the normalization of waste. One reason why individuals waste so much food is that with low food prices, they can afford to be choosy (Gustavsson et al., 2011; Rutten, 2013). Most studies confirm that as the proportion of income spent on food declines, food waste increases (Kohn, 2011). The relative price of food in Canada has declined within the last 40 years with food purchases representing only 10.2% of household expenditure budgets (Arbulu, 2012). Additionally, there is an abundant availability of food; the amount of available food per person in retail stores and restaurants has increased during the last decades (Gustavsson et al., 2011). Low food prices of widely available food discourage frugality among consumers (Gunders, 2012). The findings of WRAP's study of UK households reflects this careless attitude, with 86% (44,000 tonnes) of avoidable waste for fresh soft/berry fruit being wasted simply because it was not used in time (Quested, Marsh, Stunell & Parry, 2013a). Another study found that almost one-third of UK consumers stated that some of their berries go to waste after purchase, with 93% claiming this was because the berries "went off" before they had a chance to eat them. In the same study over half of respondents stated they were not surprised by the amount of food wasted in households, which seems to indicate the prevalence and acceptance of careless waste behaviours (Whitworth, 2013). Aside from carelessness, food may not be used in time because of poor storage techniques, poor visibility in refrigerators, partially used ingredients, and misjudged food needs (Gunders, 2012). Throwing out food is so habitual that many individuals are unaware they are wasting so much and underestimate

the amount of food they waste. The generation of food waste in the household is done privately, and as a result waste practices are not visible to others. Individuals are able to continue their wasteful behaviours without scrutiny from their peers (Quested et al., 2013a). Without a comparison, individuals believe they are no more wasteful than their neighbours. This observation is confirmed by a 2012 study of Guelph, Ontario residents, which found that people generally thought they were wasting less or the same compared to their friends and family. Furthermore, people generally thought they were wasting the same or less compared to five years ago, and would also waste less in the future (GFWR, 2014).

Waste also occurs due to poor planning, which can happen at the store and at home. At the grocery store, over purchasing beyond one's needs occurs when consumers fail to plan meals, use a shopping list, or take note of what they currently have in their pantries. As previously noted, consumers can also be influenced to make impulse, bulk, or unusual purchases (Gunders, 2012). In addition to store promotions, food retail stores are intentionally designed to subtly influence consumers to make impulse purchases. As a result, consumers now decide on 75 to 80 percent of all their food purchases in the store (Lee, Liffman & McCulligh, 2002). A Guelph, Ontario study also found that waste levels were higher for households that acknowledged that they purchase foods impulsively when they are on sale (GFWR, 2014). At home, poor planning can lead to cooking, preparing or serving too much food (Parfitt et al., 2010). In these cases, leftovers are wasted if individuals lack confidence using leftovers, if it is inconvenient, or if they simply do not like keeping leftovers (Gooch et al., 2010).

6.5.3. Lack of basic food knowledge

Household food waste occurs when consumers lack general knowledge on food safety and proper storage; organizing and preparing meals; making creative use of leftovers; and using their senses to determine if food is still edible. For example, a survey of Waterloo, Ontario residents found that most adults were not skilled in freezing and canning foods (Chenhall, 2010). Consumer deskilling describes the loss of basic food skills, and is a consequence of larger societal changes, such as shifting family priorities and time constraints. As such, there has been an increased use of pre-prepared, packaged and

convenience foods, which require fewer and/or different skills than traditional "from scratch" cooking methods (*ibid*). Jaffe & Gertler (2005) add that consumer deskilling is intentionally aided by the agri-food industry, which seeks to profit from value-added processed foods. The Canadian Food Inspection Agency (CFIA) also appears to be inadvertently aiding both consumer deskilling and waste generation by discouraging Canadians from using their senses to gauge a food's freshness. On their website, the CFIA's advice to Canadian consumers is,

> *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!'. (CFIA, 2014, their emphasis)

Understanding the loss of basic food knowledge also sheds light on how confusion over date labelling on food products contributes to waste generation. In all, an estimated 20 percent of food is thrown out as a result of confusion over the "best before" labelling (York Region, 2012). The impact of confusion over date labelling on waste generation is less for fresh strawberries, which are not subject to as many labelling regulations. However, as this is considered a significant discussion topic in food waste research, this paper presents some of the main arguments from the literature.

A variety of date labels are used on foods, including "sell by", "use by", best before" and "expiration" dates. In Canada, best before dates are required for pre-packaged foods that will keep fresh for 90 days or less; "use by" dates apply only to pre-packaged fresh yeast; and "expiration" dates are required for select products like infant formula (CFIA, 2014). Of various food date labels, best before dates cause the most confusion for consumers. According to CFIA, best before dates describe the anticipated amount of time that an unopened food product, when stored under appropriate conditions, will retain its freshness, taste, nutritional value, or any other qualities claimed by the manufacturer. Therefore, best before dates do not indicate food safety; food is still consumable after the best before date has passed (*ibid*). Unfortunately, many consumers are unaware that foods past their best before dates are perfectly edible and end up throwing them out. The confusion over best before dates, and the subsequent unwarranted fear of unsafe food, also drives waste within food retail. It is not illegal for stores to sell foods after their best before

dates, but many choose to remove items in advance of these dates in order to maintain their image of carrying only fresh products (Gunders, 2012).

The transition towards increased consumption of pre-prepared foods may inadvertently drive fresh strawberry waste due to date labelling. In Canada, fresh strawberries are not required to have date labelling, however, "best before" or "prepared on" dates are required if they are used as ingredients in ready-made foods (CFIA, 2014). When strawberries are sold fresh, consumers choose packages based on what the strawberries look like. However, if pre-cut strawberries are used as ingredients in a meal, for example in a fresh salad, consumers may be influenced to throw out edible food based on the affixed "prepared on" or "best before" date (Kohn, 2011).

6.6. Supplier-retailer relationships

A significant amount of food waste occurs along the supply chain as a result of the influence of Ontario's largest food retailers on other chain actors. Ontario's food market structure is oligopolistic, with far more producers than buyers. In this highly consolidated food retail landscape, only five companies (Loblaw, Metro, Sobey's, Costco, Walmart) control the vast majority of market share for food sales. Some scholars have identified the rise in power of supermarkets as a third emerging food regime, the corporate food regime (McMichael, 2009; Burch & Lawrence, 2009; Holt-Giménez & Shattuck, 2011). Supermarkets are the dominant intermediary between farmers and consumers (Parfitt et al., 2010). Similar to an hourglass, supermarkets act as a bottleneck controlling the flow of strawberries between growers and consumers (Porter, 2007). As top volume purchasers in Ontario, these supermarket chain companies wield a disproportionate amount of bargaining power over their suppliers. Whereas many suppliers rely heavily on a small number of buyers, supermarkets can easily choose and switch between a large number of suppliers. Additional negotiating power is gained as many of the largest food retailers also operate as national distributors (Kohn, 2011).

Due to immense competition, suppliers are willing to accept less favourable contracts for fear of being delisted by supermarket chains (Parfitt et al., 2010). Advance contracts are useful for producers to plan their activities accordingly; however, supermarkets do not share the same commitment and can cancel or change an order on a

whim, even at the time of delivery (Kohn, 2011). Retailers may reject shipments if the strawberries do not meet food quality standards, as discussed previously; if supermarket managers have inaccurately forecasted demand; if there has been a change in company policy; or if they find cheaper, or more convenient suppliers (*ibid*). In one example, an Ontario strawberry grower was forced to leave 40 percent of his crops in the field when his contract with a grocery chain was suddenly cancelled two weeks before the expected delivery (Porter, 2007). Supplier-retailer contracts usually stipulate that shipments remain in the possession of a grower and/or supplier until the moment they are accepted. As such, retailers ensure that any incurred losses, regardless of their causes, are borne exclusively by suppliers. For example, supermarkets may require suppliers to conduct quality assurance at the source, which pushes the responsibility and associated costs of inspection and handling waste onto producers (Kohn, 2011). Other contract items that maintain retailer control include product take-back clauses; payment terms and product quality standards that deter smaller suppliers; and high contractual penalties for partial or non-delivery orders (Buzby, 2012; Parfitt et al., 2010). As long as a retailer receives its desired shipments on time, what a supplier wastes is of no concern (Kohn, 2011).

Supermarket managers assert that their standards are flexible and can change based on specific market conditions. Loblaw's Eric Biddiscombe notes that their standards can change weekly for strawberries coming into their distribution centre, based on weather conditions, time of year, and availability (Kohn, 2011). While this statement appears favorable, it is more likely the case that supermarket standards for fresh Ontario strawberries become more stringent, rather than more relaxed, leading to more strawberries being rejected. Supermarkets are able to be more selective when scrutinizing strawberry shipments during peak harvest season due to abundant domestic supply. To hedge against potential losses due to bad weather and disease, as well as to ensure delivery of guaranteed quantities, producers sometimes plant in excess of what is necessary (Gustavsson et al., 2011). Overproduction may even further exacerbate food waste generation by lowering prices, leading to more crops not warranting the cost of harvest (Gunders, 2012).

Another example of asymmetrical supplier-retailer relationships is that between Walmart Canada and Ontario strawberry growers after the announcement of Walmart's

decision to source 100 percent of strawberries locally by 2013, when available. Walmart's decision to incorporate more domestically grown strawberries is driven by the need to attract customers in a highly competitive food retail landscape. Concern for the livelihoods of local growers are secondary to Walmart's ultimate goal of providing low-priced strawberries. In the case of loss-leading, a practice common in food retail, Walmart sells fresh strawberries at or below cost in order to draw in customers. Although there is a small loss for Walmart, they recuperate this loss with increased sales of other more profitable packaged goods. During loss-leading, retailers pay lower prices to their suppliers, but because suppliers do not have the same means of recuperating losses, they are forced to absorb some of the costs. According to Paul Burnham of Burnham Family Farms, "We're putting a price based on making a living out of it. They're trying to draw people into their store" (Lowe, 2011).

The power of supermarkets over their suppliers has significant impacts on the generation of waste in the supply chain. As a result of strict supplier-retailer contracts, waste occurs from over production by suppliers and from the rejection of shipments by supermarkets. In one study, researchers estimated that contractual penalties, product take-back clauses, and poor demand forecasting had a combined influence that drove 10 percent over-production and high levels of wastage in the UK food supply chain (Gunders, 2012).

6.7. Resource map for Ontario's domestic fresh strawberry supply chain

This study adapts Terry et al.'s (2011) resource map template to create a resource map for Ontario's domestic fresh strawberry supply chain. Figure 13, seen below, summarizes this study's findings on estimated loss percentages and identified causes of food waste for this chain.
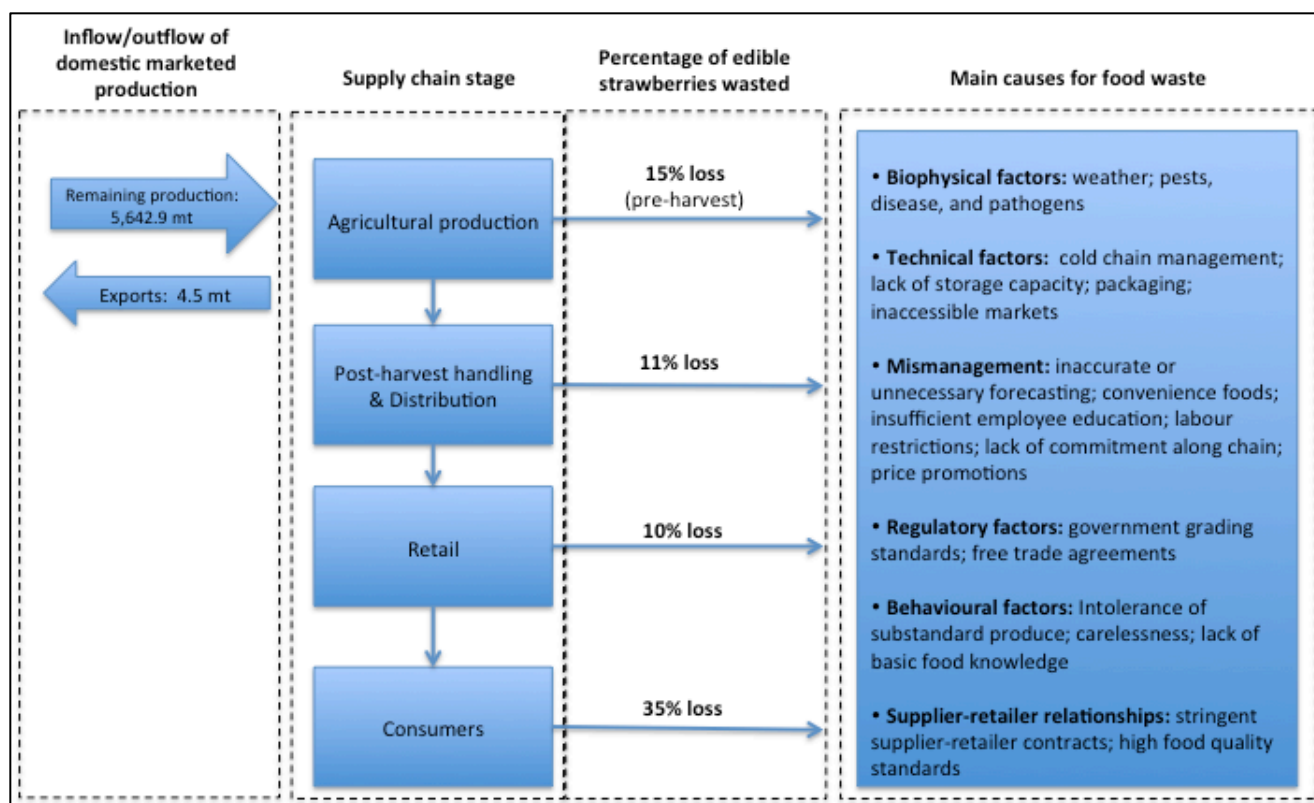
Figure 13: Resource map for Ontario's domestic strawberry supply chain.
Adapted from: Terry et al., 2011; Statistics Canada, 2014a; Statistics Canada, 2014b.

SECTION 7: DISCUSSION

7.1. Study challenges

This paper presents an estimate for the occurrence and causes of food waste within Ontario's domestic fresh strawberry supply chain. The supply chain is simplified for the sake of research, however, the reality of supply chains is much more complex. Supply chains are highly integrated with both structural and dynamic factors affecting the contributions of each actor to the chain. Supply chain stages are porous; chain actors can play multiple roles and the flow of fresh strawberries throughout the chain does not always follow a linear, sequential path. With increasing vertical integration a supply chain may also represent the flow of goods, information, and services of only one actor. Structural factors affecting the nature of a supply chain include the characteristic of the commodity (e.g. price, quantity), the enabling environment (e.g. laws, regulations, norms), and supporting markets (e.g. financial services, telecommunications). Of note are the informal

and formal relationships between actors within a supply chain, which are dynamic and continually negotiated. Relationships between chain actors are not always equal; power imbalances between actors occur, which shape the direction and flow of a supply chain (Sanogo, 2010). As such, this study's loss percentages should be considered as a best estimate and caution should be taken with its application. It is an initial attempt to unpack aggregate food waste data by focusing on one particular supply chain, of one particular industry, at a particular time, and in a particular region.

This study faces many of the same challenges identified by previous food waste studies. First, the applicability of existing data is imperfect as studies differ in their conceptualization of food waste and in their methodological approach. Second, there is simply not enough available data on food waste. The infancy of this research area is evidenced by the lack of studies. This study extrapolated from available databases, which are primarily conducted in the United States, Western Europe, and Australia. The absence of Canadian food waste studies limits a more meaningful analysis. Third, this study bases its calculations on aggregated and/or averaged values, which masks both the heterogeneity of actors and seasonal fluctuations that may affect waste generation. A deeper understanding of the differences and similarities between actors and their experiences will only foster more appropriate and effective approaches for reducing food waste.

7.2. Waste generation between import and domestic supply chains

The occurrence of food waste along Ontario's fresh strawberry supply is most likely higher relative to imported fresh strawberry supply chains. For example, waste is more likely to occur along Ontario's domestic chain due to differences in varietal selection. Ontario strawberry varieties are primarily chosen for flavour; where as imported strawberry varieties are chosen for their ability to withstand the pressures of extended transportation. Imported varieties are bigger, smoother, and less prone to damage compared to Ontario strawberries, which are less robust (Porter, 2007). Additionally, Ontario strawberries are more susceptible to waste further along the chain because they have a shorter shelf life. As noted previously, retailers prefer to purchase strawberries that have a significant portion of their shelf life remaining (Kohn, 2011). The shorter shelf life of Ontario strawberries significantly limits opportunities for producers to sell to retailers

(Terry et al., 2011). Also, consumers are increasingly favouring imported strawberries, which increases the likelihood of unsold Ontario strawberries being wasted. According to Jack Cornella, president of The Garden Basket stores, shoppers are choosing California strawberries because they "look better" than the "not so sexy" Ontario berries (Porter, 2007). Consumers also prefer California berries as they can last for weeks in the fridge, compared to only a few days for Ontario berries (Porter, 2007). Consumer surveys conducted in the UK found that half of consumers are prepared to pay more for longer lasting berries, and approximately three-quarters would purchase more berries if they could be kept fresher for longer (Whitworth, 2013).

Ontario's strawberry industry is declining with locally grown strawberries increasingly being perceived as a top-up supply. The inability to keep up with lower priced imports has caused many Ontario strawberry growers to exit the industry. According to a 2006 report by the Ontario Horticultural Crops Research and Services Committee, there has been a rapid and progressive loss of wholesale markets to the year-round flood of imported fresh berries (Ottawa Citizen, 2007). One grower noted that he now grows between 8 and 10 acres of strawberries, where as he once grew 25 acres (Shreve, 2011). Ontario strawberry growers may not be able to compete with the quantity and price of imports, however, increasing efficiencies by reducing waste may aid in developing a more viable and sustainable domestic supply chain.

7.3. Opportunities for food waste research

7.3.1. Separate analyses of domestic and import supply chains

A majority of databases, including Statistics Canada and the ERS, calculate food availability adjusted for losses for both imported and domestic fresh strawberries, with loss percentages applied indiscriminately. The market conditions for imported and domestic strawberries differ in climate, labour standards, buyer relationships and other factors, all of which impact the generation of waste along each respective chain. The inclusion of import data complicates findings, as it is difficult to gauge the level of waste that occurs before imported strawberries arrive at Ontario's borders. Given that a great deal of imported strawberries are already graded and packed at the source, it is unclear

how much waste is generated in their production (Terry et al., 2011). In order to implement effective food waste strategies, it will be necessary to understand the differences along each respective chain.

7.3.2. Inclusion of pre-harvest losses

This study chooses to include pre-harvest losses in its analysis of food waste; however, most studies, including the ERS and Statistics Canada, do not include pre-harvest losses when calculating food availability and loss-adjusted food availability. There is much debate within the research field on whether pre-harvest losses should be classified as a loss. Depending on how losses are handled on a farm (e.g. left in the field, composting, etc.), agroecologists argue that they are not losses, per se, as nutrients are eventually being returned to the soil. Conversely, other scholars note that unharvested produce still represents a lost opportunity to provide nutrition and may not be the most efficient use of the resources used to grow these crops (Gunders, 2012). Regardless of its classification as waste or non-waste, characterizing the occurrence and causes of pre-harvest losses is unequivocally beneficial to the larger body of food waste research. Trends in pre-harvest losses may signify wider issues within the supply chain and the food system in general.

7.3.3. Need for accurate and updated food waste databases

There is a need to update and maintain accurate food waste databases, which are integral for conducting research and proposing appropriate solutions. Statistics Canada maintains a database on food availability adjusted for losses (FAALs) for fresh strawberries, based on the approaches used by the ERS. Food availability adjusted for losses is an estimate of the total amount of food consumed by Canadians after accounting for losses occurring at the retail and consumer levels (Statistics Canada, 2012d). Upon closer inspection of this database, this study has discovered that Statistics Canada has not updated its methodology in accordance with changes made by the ERS. The ERS (2014) updated its retail loss percentage for fresh strawberries in 2009 and its consumer level loss percentage in 2012; Statistics Canada has not updated either of these percentages, even as it continues to issue FAAL data (as of 2013). Statistics Canada calculates FAAL for fresh strawberries using older retail level loss percentages of 12% and consumer level loss

percentages of 20%, rather than 9.8% and 35%, respectively. Statistics Canada's average value for fresh strawberry FAAL between 2008 and 2012 is 2.31 kg/person/year, while updated percentages reveal FAAL averages over the same time period to be only 1.86 kg/person/year (Statistics Canada, 2014d). Table 9 compares Statistics Canada's current values for FAAL for fresh strawberries with updated values that reflect the ERS's new loss percentages.

	2008	2009	2010	2011	2012	5-year average
Statistics Canada's values for food availability adjusted for losses	2.02	2.19	2.29	2.52	2.54	2.31
Updated food availability adjusted for losses	1.62	1.76	1.85	2.03	2.05	1.86
Difference	0.40	0.43	0.44	0.49	0.49	0.45

Table 9: A comparison of Statistics Canada's values for food availability adjusted for losses with updated values calculated using ERS's new loss percentages for fresh strawberries, 2008-2012 (kg/person per year).
Adapted from: Statistics Canada, 2014d; ERS, 2014.

Statistics Canada's FAAL values are higher than should be calculated using updated loss percentages. Similarly, the amounts of waste at the retail and consumer stages are significantly higher than reported by Statistics Canada. The difference in FAAL of 0.45 kg/person/year amounts to a discrepancy of 15,565 tonnes of strawberries each year. If the same calculation were conducted for Ontario, the discrepancy would be 1.08 kg/person/year, which is the equivalent of 14,039 tonnes! (Statistics Canada, 2014b; Statistics Canada, 2014d). Aside from outdated methodologies, another challenge for calculating FAAL is that Canada does not have reliable food consumption data. Statistics Canada's does acknowledge that the loss factors used in their calculations are estimates and caution use of their data. However, there are still implications if individuals choose to use Statistics Canada's FAAL data without scrutiny. For example, underestimating the amount of waste generated at the retail and consumer levels may cause policy makers to falsely believe that food waste reduction strategies are not necessary. By highlighting the discrepancy in Statistics Canada's FAAL database, this study demonstrates the difficulties in maintaining accurate and updated information regarding food waste.

7.3.4. Further recognition of supermarket dominance as a cause of food waste

Additional research is needed to understand the impacts of supply chain relationships on food waste generation, especially as it relates to the dominance of food retailers. More so, food waste studies independent of corporate influence should be conducted. This paper confirms the findings of Kohn (2011) that supermarkets hold disproportionate power in Ontario's domestic fresh strawberry supply chain. Food retailers control the activities of potential and current suppliers using inequitable supplier-retailer contracts. Food retailers also shape consumer behaviours using mechanisms like multi-buy and price promotions. Through these interactions, supermarkets promote waste generation along the chain and have largely succeeded in pushing the associated costs of waste onto other actors. Given the immense power of the major supermarkets over other actors, initiatives that seek to balance this power could be significant in reducing food waste along the whole chain. A growing number of food waste studies recognize this correlation, however, a large portion continue to ignore the systemic impact of supermarkets on waste generation. Political or business interests may drive the relative absence of studies that are critical of the power of supermarkets. In fact, agri-food interest groups and companies fund many food waste studies. For example, the Grocery Manufacturers Association (GMA), the Food Marketing Institute (FMI), and the National Restaurant Association (NRA) recently formed the Food Waste Reduction Alliance (FWRA), which has commissioned a series of reports on food waste in the United States (FWRA, 2014). Canada's leading food waste study by Gooch et al. (2010) was funded by VCM International (VCMI), an interest group dedicated to "improving the profitability and competitiveness of commercial businesses" (VCMI, 2014). Similarly, in October 2013 VCMI hosted a food waste forum attended by representatives of North America's food and drink industry aptly named "Cut Waste, Grow Profit" (*ibid*). For many industry-funded studies, the generation of food waste is not conceptualized as a consequence of the power of agri-food corporations over their supply chains, but is instead framed in relation to natural phenomena, inefficient technologies, or behavioural factors. For example, Gooch et al. (2010) identify the underlying causes for food waste as individual behaviours, categorized into consumer behaviour, management decisions, and the unintended consequences of policy and legislation. The authors also cite Cranfield University's cause and effect fishbone,

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seen in Figure 14, which shows that food and packaging waste is caused by issues relating to measurement, machine/equipment, people, methods, environment, and materials. In both cases, there is little recognition of the impact of supply chain relationships on waste generation, and there is no mention of the power of food retailers over other actors. Gooch et al.'s (2010) report does note that food waste is partly caused by a lack of desire by chain actors to work collaboratively, yet the authors stop short of critically examining the motivations or limitations creating this situation.
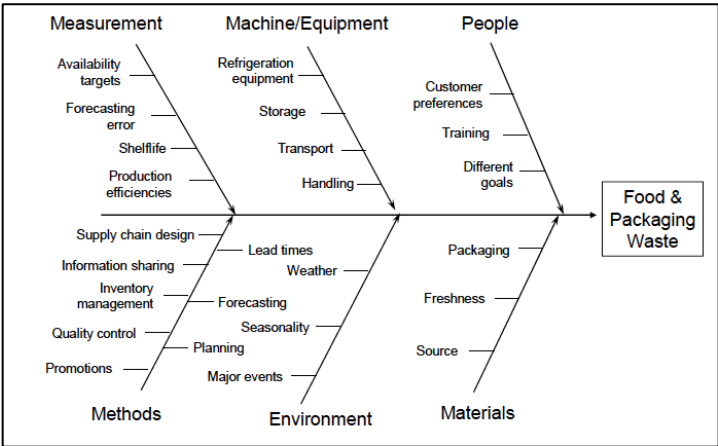
Figure 14: Cranfield University's cause and effect fishbone for food and packaging waste.
Source: Gooch et al., 2010.

It is in the agri-food industry's financial interests to fund studies that conceptualize the causes of food waste as external to their structure and power in the supply chain. Based on this reasoning, subsequent reduction strategies would not require significant changes to the corporate food retail model that may jeopardize the food industry's power and profitability. Additional research, independent of corporate influence, is needed to examine the impacts of supply chain relationships and food retailer dominance on waste generation. Until this type of research is comprehensively undertaken, stop gap approaches for reducing food waste will continue to be prioritized over more systemic changes.

SECTION 8: SUGGESTED FOOD WASTE STRATEGIES

8.1. Overview

What targeted approaches should be taken to effectively reduce food waste in Ontario's domestic fresh strawberry supply chain? Furthermore, how can food waste

strategies improve the viability and sustainability of Ontario's domestic strawberry industry and promote equity between supply chain actors? Past experience in Europe shows that measures to improve resource efficiency have been more successful when they are targeted at specific steps of the supply chain involving a few key actors. Improvements that have been less effective are measures that require the actions of many fragmented actors, such as changes in consumption habits or in the agricultural sector (Grizzetti et al., 2013). Taking into account the complexity and fluidity of the supply chain, its actors, and supply chain relationships, implementing solutions for reducing food waste is not always simple. Reduction strategies targeted at one stage of the chain may not result in corresponding improvements. Conversely, implementing a solution at one level of the supply on chain on a single measure may reduce food waste at that particular level, but may not necessarily reduce food waste in the entire food chain (Kohn, 2011).

Food waste is both a symptom of and contributor to the dominant food system. A small number of powerful actors dictate the structure and priorities of the food system at the expense of the environment, public health, and individual livelihoods. As such, strategies for reducing and preventing food waste are part of a larger transformation towards a food system that is more ecologically sustainable, health-oriented, and equitable. This study suggests several short-, medium-, and long-term food waste strategies following the efficiency-substitution-redesign (ESR) framework. Strategies become more comprehensive as they move along the framework, requiring increasing levels of time and resources for their implementation and for overcoming resistance from supply chain actors (TFPC, 1994). The underlying basis of the ESR framework is that gradual policy changes can be both rooted in, and help create, larger paradigmatic shifts. Ideally, Canada's policy goals, institutional arrangements, and instruments should be aligned with the goals of a food system that are coherent, transparent, comprehensive, and joined-up (MacRae, 2011).

8.2. Efficiency strategies

Efficiency strategies involve minor changes to existing operations or practices or involve removing obstacles for participation. These are short-term strategies that are easier to implement and less likely to impose the least prohibitive costs on chain actors (MacRae, Lynch & Martin, 2010). This paper suggests several efficiency strategies, whose

overall emphasis is on increasing the visibility of food waste and on increasing its donation and diversion.

8.2.1. Increase and/or reallocate agricultural research funding for food waste research

The problem of food waste has persisted partly because it is not being measured or studied. Currently, less than 5 percent of funding for agricultural research is being allocated to post-harvest systems and loss (Parfitt et al., 2010). In the short-term, Ontario should increase or re-allocate agricultural research funding for food loss and food waste research. This paper also suggests a concerted effort by food waste scholars to clarify definitions of food waste and to establish a standard for its measurement. Ideally, common terminology should be used moving forward to promote consistency and to promote useful comparisons between studies. Reliable loss estimates, as well as an understanding of the causes for food waste, are needed to identify where food waste can be minimized efficiently. Policy makers and private business need reliable information in order to conduct cost-benefit analyses of specific loss-reducing initiatives (Buzby & Hyman, 2012). Research is also needed to evaluate the impacts of current policies and inform whether other policies could provide meaningful incentives to reduce food waste. Increases to, or reallocations of, funding for food waste research can be done almost immediately and do not require significant financial or administrative resources for implementation. More importantly, by fostering a better understanding of the issue, more effective reduction and prevention strategies can be subsequently proposed and evaluated.

8.2.2. Consumer education campaigns

As discussed, consumers are significant contributors to the generation of strawberry waste, throwing out strawberries due to intolerance for substandard produce, carelessness, and a lack of basic food knowledge. Educational campaigns are short-term solutions that act to increase consumers' knowledge and awareness of food waste. They are low-cost strategies that can easily be implemented by the private or public sector. Individuals are becoming more aware of the issue, however, they do not always have a good understanding of how they contribute to the problem and what they can do to help

reduce food waste (GFWP, 2014). A survey of US households found that 63% of consumers felt food waste was a problem in the US, yet only 34% believed that *their* household contributed to the problem (Watson, 2014). Similarly, when Guelph, Ontario residents were asked what they could do to reduce waste, almost 40% of respondents could not think of anything (GFWP, 2014). Studies show that once people are aware of the value of their losses, then there is more commitment to handling food better. Educational campaigns can be used to inform consumers about the amount and value that they waste annually, including its share relative to their household's budget. They can also be targeted to inform consumers about food purchasing skills, meal planning, using leftovers, gauging what is safe to eat, and interpreting date labeling (Hodges et al., 2011). Additionally, efforts can educate consumers to accept a certain waste tolerance, that is, to accept that a package of strawberries is still edible, even if one strawberry is damaged or spoiled (Terry et al., 2011). Furthermore, "Buy Local" campaigns can also be incorporated to encourage consumers to support Ontario growers by purchasing more local berries (TFPC, 1994).

There are several examples of how to implement educational campaigns. One example could be to provide proper storage and handling instructions near the product display, on small take-away cards, or on the package of strawberries themselves. Another example is the introduction of mobile phone applications, which provides educational materials and tools to assist consumers with reducing their waste. Figure 15 shows a screen shot of Love Food, Hate Waste's (2014) mobile phone application, which helps consumers know how long products have been in their refrigerator, plan meals, and create shopping lists. A third example could be educating consumers using print, radio, or television public service announcements, such as the food waste commercial commissioned by the Scottish government in 2014 (Greener Scotland, 2012).
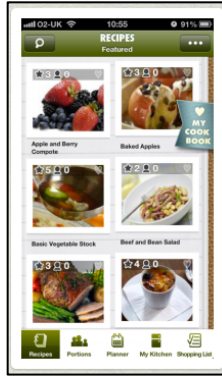
Figure 15: A screen shot of Love Food, Hate Waste's mobile phone application.
Photo credit: Love Food, Hate Waste, 2014.

Education strategies will only prompt action if consumers believe that their actions are meaningful. Therefore, education campaign architects must understand the motivations that drive consumers to waste and how consumers frame this issue. According to Guelph Food Waste Project's survey (2014), many households do not perceive waste to be a significant environmental problem; rather, most respondents thought of food waste as first and foremost a social issue. As such, educational campaigns may be more effective in shaping consumer behaviour by framing the issue more in relation to its social impacts, rather than its environmental or economic consequences. To some extent, food waste reduction campaigns should build off of people's guilt over throwing out edible food as many others go hungry.

Educational campaigns are the most preferred food waste reduction approach, receiving high political acceptability because they are low-cost and do not require changes to current food business models. Agri-food corporations may even benefit by promoting positive images of their commitment to consumer cost-savings, sustainability, and feeding the hungry. Overall, educational campaigns act as a beginning step towards changing long-term consumer attitudes regarding food waste.

8.2.3. Retailer efficiency strategies

There are three initial strategies that food retailers can implement to reduce or prevent food waste. First, retailers can make simple modifications to product displays, ensuring that strawberry packages are properly presented (Terry et al., 2011). Retailers

sometimes take strawberry packages out of crates and stack them on their ends to minimize shelf space, which increases waste, as packages should be presented flat as per their design. Other times, retailers do not put strawberries on refrigerated shelves, which further add to potential spoilage. Second, retailers could sell strawberries that are close to expiry at discount more often and adjust certain price promotions to discourage consumers from over purchasing (Gunders, 2012). For example, food retailers can shift from traditional "buy one, get one free" promotions towards "buy one, get one free later" (Gooch et al., 2010). Third, to assist in minimizing food waste within food retail and food service operations, standard employee training procedures could be modified to include a short review of prevention and reduction strategies. The inclusion of this training will not impose significant labour costs and should result in noticeable reductions in waste caused by employee error.

8.2.4. Facilitate redistribution and diversion

A significant amount of edible strawberries are thrown out and sent to landfills, instead of being redistributed to community food organizations or diverted to alternate processing facilities. In the short-term, several strategies could and have been implemented to encourage the redistribution or diversion of excess food. There are two key pieces of legislation by the Ontario government that facilitate the redistribution of food for donation. The Ontario government is already in the final stages of establishing a community food program donation tax credit for farmers. As part of the *Local Food Act, 2013*, Bill 36 amends the *Taxation Act, 2007*, providing farmers with a tax credit of up to 25% of the market value for donated produce ("Bill C-36", 2013). Additionally, the *Donation of Food Act, 1994* protects donors from liability for any risks associated with food donated in good faith ("Donation of Food Act", 1994). While these pieces of legislation are encouraging, their effectiveness for increasing food donations remains uncertain. First, potential benefits may not be realized if either the benefactor or community food organization lacks supporting infrastructure. In a comparable survey of US food manufacturers, retailers, and wholesalers, half of respondents cited insufficient storage and refrigeration at food banks and a lack of refrigerated trucks and drivers as barriers to donating food (BSR, 2013). In

order to facilitate food donation and to bolster the effectiveness of the tax credit, corresponding investments should be provided to improve transportation and storage infrastructure, which can be in the form of capital grants. Second, despite the protections provided by the *Donation of Food Act* many companies choose not to donate food because they are still concerned about liability and any potential negative publicity that may ensue. These fears are unfounded, as no lawsuits have ever been documented against a donor (Cohen, 2012). Outreach and education to the private sector by the government and private charities may assist in overcoming this limitation.

Another approach to facilitate food donations is fostering linkages between volunteers and charitable organizations and producers, food retailers, and food service outlets. For example, governments and businesses should encourage innovation in online solutions, such as Ample Harvest, which quickly connects potential donors with community organizations (Gunders, 2012). Additionally, coordinating volunteer gleaners from charitable organizations can help offset the high labour costs that usually deter farmers from harvesting excess or left over strawberries.

Another aspect is that it is cheaper for businesses to dispose of strawberries than to redistribute, reuse, or divert them. One efficiency strategy for discouraging landfilling is to increase tipping fees at landfills, thus increasing the financial incentive of companies to waste less. Likewise, to encourage residents to waste less and divert more organic waste, municipal governments can increase waste management fees while also providing organic waste collection at no or little cost. The City of Toronto has a similar waste management structure in place, which has proven to be relatively successful. In 2012, 89% of single-family households participated in the city's Green Bin Program, diverting an average of 260 kg of organic waste per household (City of Toronto, 2013). To support the increase in organic waste diversion, subsequent substitution strategies will need to be implemented to increase organic waste collection and processing capabilities.

8.2.5. Improve packaging options

There are concerns about the environmental impacts of packaging and its role in waste generation; however, even small packaging improvements can have significant

impacts on reducing waste. Ontario strawberries are typically sold in open-top paper fibre or wood containers and open-top mesh plastic containers, which do not optimally protect strawberries from physical damage or degradation. While strawberry packaging has not changed substantially in recent years, there are examples of promising packaging improvements. For example, Marks and Spencers, a grocery chain in the UK, reduced strawberry wastage in their stores by 4 percent by using new packaging. Small ethylene absorbing strips inserted into packages extended the shelf life of strawberries by two days. Due to this new packaging, an estimated 800,000 strawberries are not being wasted during the peak summer season (Business Green, 2012). Another technological advance is the use of heat-sealed lids, which considerably reduces pack weight while still maintaining product protection (Terry et al., 2011). Packaging waste can also be addressed if packages are designed to use fewer materials or incorporate recyclable or biodegradable materials. However, communication between the food and packaging industry, as well as with municipal and regional authorities is needed to ensure new packaging designs are compatible with municipal recycling programs. To promote the use of more innovative packaging, short-term strategies should first clarify the potential of packaging for reducing waste to chain actors and consumers. This is a low-cost approach, as producer and retailer organizations can quickly disseminate information to their members. Consumers can also be informed through the use of educational campaigns.

8.2.6. Equipment retrofit grants

Supply chain actors may generate waste due to inefficient equipment or a lack of equipment and storage facilities. A majority of Ontario strawberry growers operate small- and medium-scale farms and often do not have the resources to purchase sophisticated field-chilling equipment, refrigeration systems, and temperature monitoring software. If field heat is not quickly removed, the shelf life of the strawberries is significantly reduced, which limits the time for local growers to ship produce and facilitate transit to stores (McCallum et al., 2014). In the short-term, retrofit grants help offset the costs of improving or installing new equipment, thereby encouraging participation in regional food networks and in waste reduction strategies. Furthermore, Ontario's Ministry of Food and Agriculture can also adjust current agricultural extensions to support energy efficiency (TFPC, 1994).

In summary, this paper suggests several efficiency strategies, ranging from increasing funding for food waste research to facilitating the donation of excess food. These efficiency strategies cannot be considered an end in itself because they fail to address the underlying reasons driving the generation and normalization of food waste. However, efficiency strategies can help create an environment somewhat more conducive to the desired long-term change (TFPC, 1994). If efficiency strategies are properly designed, this enables the implementation of substitution strategies, which are reviewed next.

8.3. Substitution strategies

Substitution strategies describe medium-term approaches that replace one measure by another, or add a parallel measure with a similar structure but different intent (MacRae et al., 2010). Compared to efficiency strategies, substitution strategies are more complex and require more resources and time for their implementation. Substitution strategies induce more systemic changes and can impose additional costs, which may explain why some participants will be resistant (TFPC, 1994). This paper presents several substitution strategies, whose overall goals are to increase transparency, communication, and cooperation between supply chain actors.

8.3.1. Establish food waste reduction targets

National, provincial, and municipal governments, as well as individual businesses, should establish clear and specific food waste reduction targets. The establishment of reduction targets provides governments and chain actors with a defined goal in which to strive for. They help prioritize the reduction of food losses and foster a supportive environment for their achievement. Target reductions also act as consistent benchmarks to assess the progress of associated strategies (Gunders, 2012). The ability to set appropriate reduction targets is enabled by previous efficiency strategies which provided support to expand food waste research.

Compared to national targets, local and provincial food waste reduction targets will be easier to establish, as there are fewer stakeholders to consult and coordinate activities. The Ontario government sets the province's waste regulations, while municipal and

regional governments deliver waste management services (MOECC, 2013). Provincial targets can help set the tone for local governments to act and can provide direction and infrastructure to enable food waste prevention programs (Gunders, 2012). The European Parliament's commitment to reduce food waste by 50 percent by 2020 acts as a guiding example (EC, 2012). An analysis of the opportunities and challenges of the EU's waste reduction strategies can inform relevant approaches in Ontario and Canada.

8.3.2. Conduct regular food waste audits and share results

Companies are beginning to conduct internal food waste audits, however, much of this research does not provide a detailed breakdown of data (Kohn, 2011). Following this, chain actors should conduct timely and accurate measurements of the levels of food waste in their operation. Food waste audits provide baseline data and can assist businesses with evaluating goals and highlighting opportunity areas for savings (Gunders, 2012). In addition, if the resources are available, third-party endorsements can be used to confirm the accuracy, reliability, and objectivity of food waste audits. Ideally, audits should be shared among chain actors and researchers in a collaborative approach and best practices should be shared to encourage other businesses to adopt them. Supply chain actors are likely to be resistant to sharing meaningful information, however, increased communication between actors may assist in overcoming their reservations.

8.3.3. Promote communication and collaboration between chain actors

Promoting communication and collaboration between chain actors is vital for reducing food waste in Ontario's domestic fresh strawberry supply chain. Communication gaps persist between actors of the same supply stage and between actors of different stages. Communication is essential for ensuring that local strawberries move quickly through the distribution system before they spoil. For example, communication between growers, transportation carriers, and distribution centres allows a retail chain to adjust its store deliveries to prioritize local strawberries, which will spoil sooner, over precooled imported strawberries (McCallum et al., 2014). In another example, communication between farmers reduces waste if surplus crops from one farm can be used to help solve the shortage of crops in another (Stuart, 2009).

In their study, McCallum et al. (2014) found that a lack of cooperation among local farmers and the reluctance to join a cooperative have limited the potential of local growers to access larger retail markets. As it will be discussed shortly, farmer cooperatives are the primary way for local growers to meet the volume requirements of major retailers. Individual farmers choose to try and sell privately rather than join a cooperative in the belief that they have the capacity to handle sales and logistics on their own and that their products are superior to their peers. As a result, fewer strawberry shipments are aggregated for large retailers. Producer associations can help increase communication between growers by acting as a centralized node connecting farmers. They can quickly relay information and facilitate linkages between members. During the winter season, producer associations can also host networking events and workshops that facilitate relationship building between farmers.

A level of mistrust between suppliers and retailers continues to affect the efficiency of the supply chain, leading to the generation of waste. Some growers believe that stores should sell whatever they grow, rather than only strawberries that meet retailers' particular specifications. Conversely, retailers find it difficult to deal with a large number of local growers, who range in consistency regarding timely shipments and meeting a store's volume and quality requirements (McCallum et al. 2014). Increasing communication between suppliers and retailers assists with identifying common goals and challenges and may reveal areas for collaboration (Tupper & Whitehead, 2011). Retailers may even be more amenable to introducing more flexibility in contract terms and grading if they have a better understanding of suppliers' operations and constraints (Gunders, 2012).

There are several factors that can affect the development of business relationships between suppliers and retailers, including the location of the grower, the size of the farm, and the uniqueness and quality of the product grown at the farm (McCallum et al., 2014). While some structural factors cannot be changed, there are other changes that can be made to improve supply chain relationships, including: having regular meetings between retailer and supplier teams; introducing or increasing daily communications with suppliers; improving tools for decision making; and establishing regular checkpoints to review progress (Tupper & Whitehead, 2011). Retailers and suppliers can also develop an understanding of each other's businesses by conducting a "walk through" of the entire

supply chain (*ibid*). The formation of food waste reduction alliances can help promote cooperation among supply chain actors and the wider food industry. For example, PAC Food Waste is a food waste reduction initiative of North America's packaging industry that includes more than 30 organizations across the supply chain. By sharing the expertise and resources of its members, PAC Food Waste is collaboratively working on packaging solutions for reducing food waste (PAC, 2014). Increasing communication between suppliers and retailers can have significant impacts on reducing waste. This is confirmed by a recent UK project that found noticeable waste reductions in all six case studies as a result of increasing supplier-retailer collaboration (Tupper & Whitehead, 2011).

8.3.4. Foster farmer cooperatives

A significant amount of waste occurs from the inability of Ontario producers to compete with the price and quantity of imported strawberries. This is in part because local growers lack supporting infrastructure to locate, coordinate, plan, process, track and distribute strawberries to buyers (McCallum et al., 2014). Ontario should facilitate the formation of farmers' cooperatives, which are often the only way smaller growers can access larger food retail stores. Farmer cooperative act as central points for assembling strawberries from small farms and preparing consolidated shipments for transportation to markets and other distribution channels. As such, farmer cooperatives assist in upscaling local production and marketing. By centralizing numerous small farms, farming cooperatives increase the efficiency of grower operations, which lead to less waste (Gustavsson et al., 2011). Cooperatives assist Ontario growers by ensuring consistent sales at fair prices, providing storage and delivery of strawberries to retailers, and providing liability insurance for its members (McCallum et al., 2014). Ontario should provide initial administrative and financial resources to assist the formation of potential cooperatives. For example, provincial researchers could examine the distribution of current farmer cooperatives to identify areas for new cooperatives to form or to identify opportunities for strengthening existing cooperatives. Regular communication between the provincial government and farmer cooperatives will be needed to review a cooperative's progress and address any challenges.

8.3.5. Increase access to organic waste diversion programs

The Ontario government should provide support to municipalities and businesses that are interested in implementing or increasing organic waste diversion as part of their waste management strategy. In Ontario, many municipalities and businesses are enthusiastic about organic waste diversion, but do not have either the collection or processing capacities to support their initiatives. Municipalities are not required under *Ontario's Waste Diversion Act* to collect food waste. While most large municipalities in Ontario have already implemented organic waste collection voluntarily, a significant amount of Ontario's municipalities do not have such programs (MOECC, 2013). There are several alternative methods for processing organic waste other than landfilling, including aerobic composting, anaerobic composting, and anaerobic digestion. However, if there are no available facilities or if current facilities are at capacity, diverted organic waste is redirected and usually sent to landfills. Subsequently, any efforts to divert organic waste will be in vain and any benefits from its diversion will be squandered. For example, the City of Toronto's Green Bin Program (GBP) is one of the largest organic waste diversion programs in North America. In 2013, the GBP collected over 110,000 tonnes of organic waste, however, the city's organic waste processing capacity is only 80,000 tonnes per year. Until processing capacity increases, Toronto continues to send over 30,000 tonnes to private contractors (City of Toronto, 2013). Unfortunately, the procedure for building supporting organic waste processing facilities is long-term and cost prohibitive for many municipalities and businesses (Gooch et al., 2010).

To address current and future demand for organic waste diversion, Ontario should provide support to implement and expand access to organic waste diversion programs. A variety of supports can be used, including: providing consultations and expert advice; providing designated transfer payments to municipalities; and providing access to grants or low interest loans for businesses. Municipal planning departments may also require new multi-residential buildings to have organic waste collection infrastructure incorporated into its design. Ontario's Ministry of the Environment and Climate Change (MOECC) should also classify organic waste as a designated waste under its *Waste Diversion Act*, and forthcoming *Waste Reduction Act*. Under current legislation, Waste Diversion Ontario and industry-funded organizations (IFOs) are required to co-develop diversion programs for

any designated waste. More so, each diversion program is required to be partially funded by the relevant industry (MOECC, 2013). Classifying organic waste as a designated waste enables the expansion of organic waste diversion programs in Ontario by providing stable funding. By requiring the food industry to partially fund diversion programs, it provides financial incentives for related companies to reduce and prevent food waste. In addition, Ontario should extend its waste legislation to require organic waste separation and collection across the entire industrial, commercial and institutional (ICI) sector, which has until now not been subjected to these regulations. Lastly, to increase diversion Ontario should transition to a full ban of organic waste from landfills, which would apply to both residents and businesses. In order for organic waste disposal bans to be effective, alternatives to properly manage organic waste will need to be in place and widely available. Metro Vancouver is set to implement an organic waste ban in 2015, which may provide guidance to Ontario and its municipalities (Metro Vancouver, 2014).

Policy makers must consider potential implications that may occur from implementing certain waste reducing measures. Direct rebound effects (DREs), or take-back effects, may occur that offset some of the benefits of expanding organic waste diversions programs. For example, providing organic waste bins encourages diversion from landfills; however, the environmental benefits associated with diverting more organic waste are reduced if individuals end up producing more waste. Green bins act as "guilt erasers", leading individuals to feel as though they are doing a positive thing for the environment by separating out their food waste. They are not led to think of the resource use and environmental impact of their food waste that occurs further up the chain. Organic waste bins prioritize the value of recycling and diversion over the long-term strategy of reduction (GFWP, 2014). To overcome this limitation, a corresponding education campaign on waste reduction should be used and volume charges for organic waste collection should be incorporated. Similarly, an expansion of waste-to-energy facilities may have unintended consequences which limit expected benefits. One suggestion by Gooch et al. (2010) is that at the very least, all levels of government should lessen the permit and regulatory hurdles that face waste-to-energy projects. However, if relaxed regulations do not maintain comprehensive environmental requirements, waste-to-energy facilities may be constructed that produce net negative environmental impacts. There is also concern that as anaerobic

digestor facilities require a continual supply of organic waste to remain profitable, this could potentially divert food from feeding programs (Hodges et al., 2011). Overall, organic waste diversion and reduction strategies should still be pursued, however, policy makers must be mindful of potential take-back effects that may occur from these approaches.

8.3.6. A note on government grading standards

Labelling and grading regulations in Canada and Ontario were originally introduced to prevent product misrepresentation and fraud, protect health and safety, and assist consumers with making informed choices (MacRae et al., 2012). Some side effects of these regulations, however, were that they imposed additional costs onto produce growers and packers and prevented them from selling subgrade produce to secondary processing markets. Because regulators have also focused on conveying information to consumers based on narrowly defined parameters of price, quality, and convenience, grading systems have acted to shift consumers' understanding of food quality (*ibid*). As a result, many consumers equate cosmetic standards with a product's nutritional value, which is often not the case (TFPC, 1994).

Changing circumstances in consumer demand and market structure have prompted the Ontario government to eliminate grading, packing, and packaging standards for fresh market commodities grown and sold in the province. Consumers are increasingly expressing their desire to be able to buy a wider selection of produce as they become more aware of food waste and larger food system issues. Ideally, by removing grading standards fruit and vegetable growers are able to access additional processing markets. By eliminating regulatory burdens related to these standards, the Ontario government intended to make it easier for businesses to operate and respond to consumer demands ("Food and Safety Quality Act", 2001). It is also suggested that a decrease in government quality standards helps reduce food waste; however, the removal of Ontario's grading standards for fresh strawberries in 2011, amongst other removals, demonstrates that this is not necessarily true. Unfortunately, chain actors do not believe that the removal of Ontario's grading standards was effective in reducing food waste within their own operations and the supply chain as a whole. They believe that as long as consumers and

retailers continue to insist on food quality standards higher than is regulated, government standards, or the removal of government standards, are meaningless for waste reduction.

Alternately, it has been suggested that establishing government regulations based on a ceiling standard, which retailers cannot surpass, may be helpful for reducing waste (Kohn, 2011). This approach is promising, however, it is unlikely to receive initial political and industry support. Supermarkets will oppose any regulations that limit their ability to choose what they purchase and from whom. Until consumers prioritize real quality parameters, like nutritional value, over cosmetic ones, they are also unlikely to be supportive. Furthermore, ceiling standards may create tension between chain actors when establishing how to sell strawberries that exceed ceiling standards. However, developing and building support for ceiling standards may still be possible over time with increased communication and collaboration in the supply chain.

Overall, this paper's substitution strategies introduce the process of improving supply chain communication and collaboration, which are needed to overcome mistrust and to overcome embedded beliefs that support traditional supply chain relationships and business models. However, establishing a truly open and equitable supply chain will require long-term redesign strategies.

8.4. Redesign strategies

Redesign strategies require the longest time and the most resources to implement, with fundamental changes to human and resource use (MacRae et al., 2010). Redesign strategies are based on reconceptualizations of both the roots of food waste and the solutions that will address them. Ideally, for redesign strategies to be achieved efficiency and substitutions strategies should first be attempted and analyzed (TFPC, 1994). Redesign strategies support the principles of agroecology, which conceptualize food waste not as waste, but as an integral link in closed loop food systems. Similarly, linear supply chain models develop into closed loops, with waste of all forms fed back into the chain. This paper presents six redesign strategies for preventing food waste and promoting sustainable and equitable food systems.

8.4.1. Mandatory food waste reporting

Maintaining a consistent and comprehensive database on food waste is important for understanding the depth of the problem, evaluating previous initiatives, and informing future policies (Mena et al., 2011). The Ontario government should consider mandatory food waste reporting for all institutions and private businesses. Extensive administrative and human resources are required to ensure compliance and to synthesize data. To support this approach, government departments should also be redesigned to increase their capacity to collect data and direct future policy initiatives. In particular, interdepartmental linkages should be established to facilitate communication and promote common waste prevention goals.

8.4.2. Introduce new government standards based on real quality standards

New government standards based on real quality parameters, such as flavour and nutritional value, should be introduced. Establishing new federal quality standards based on real quality parameters would allow slightly blemished or undersized strawberries to be equally valued compared to traditionally graded ones. In addition to further increasing producer access to alternate markets, these new quality standards assist in increasing consumers' acceptance of blemished, but nutritionally equal strawberries.

8.4.3. Full cost pricing

A sustainable food system should adopt full cost pricing for strawberries and other food products, which incorporates the real environmental, social, and health costs associated with producing, distributing, consuming, and disposing of an item (TFPC, 1994). The current low price of strawberries and related disposal costs exclude externalities and thus provide no financial incentive for consumers and other chain actors to change their behaviours to waste less.

8.4.4. Enable informed and engaged consumer-citizens

Long-term consumer education is needed to ensure that every individual possesses proper and full information in order to make informed food decisions. Strategies should also foster the development of practical food skills relating to informed shopping, food storage and preservation, and food preparation. The food industry asserts that their actions

are simply a response to consumer demands for price, quality, and convenience. However, there is increasing evidence that more consumers are concerned about broader environmental, social, and health issues such as food waste and supporting local food economies (MacRae et al., 2012). Yet, as Jaffe & Gertler (2006) argue, "…consumers do not have- and are systematically deprived of- the information, knowledge, and analytical frameworks needed to make informed decisions that reflect their own 'fully costed' interests" (p. 143). Furthermore, most consumers are unaware of how their food choices can be used to exercise real influence within the food system. In part due to consolidation in the food sector and incomplete state regulation; significant information asymmetries continue to typify the consumer information environment (MacRae et al., 2012). As a result of consumer deskilling, individuals no longer possess first-hand knowledge to engage with the physical and sensual qualities of food. They no longer trust their own sense of taste, smell, look, and feel and instead rely on receiving directives from food companies and regulators. Consumers are systematically schooled to focus more on superficial issues such as the crunch of breakfast cereal, rather than on deeper issues such as hunger, the distribution of power and control in the food chain, and the ecological impacts of production and consumption (Jaffe & Gertler, 2006).

Without deliberate steps to combat deskilling, consumers will become progressively less skilled, in absolute and relative terms, as they become increasingly removed from the sites and processes of production. As the structure of the food system changes, the information required for consumers to make informed decisions will similarly change. There is also no minimum level of food knowledge and skill, as it differs between consumers and circumstances (Jaffe & Gertler, 2006). Furthermore, there will be challenges that limit the success of strategies, including time, individual or familial food choice, and a diminished value placed on traditional cooking skills (Chenhall, 2010). However, with some level of food knowledge and skill, consumers are empowered to make real food choices and to extract real value from money spent on food (Jaffe & Gertler, 2006).

Provincial ministries of education must recognize that the development of food knowledge, including practical foods skills, is an integral component of an individual's overall education. Provincial ministries of education, with support from other levels of government, should incorporate these skills into school curriculum, across several

disciplines. Additionally, until the regulatory system recognizes and addresses information asymmetries in the food system, consumers will continue to struggle to make informed food decisions (MacRae et al., 2012). The federal government should implement strategies to redesign consumer information systems to ensure that full and transparent information is available to consumers. For example, as MacRae et al. (2012) suggest, the state could implement comprehensive product labeling that includes information on the environmental and social justice impacts of production, processing, and distribution.

Lastly, food citizenship should be fostered so that individuals can make meaningful contributions to the development of food policies and programs, which has historically only involved a narrow range of economic interests. The governance of the food system must shift to increase access to the decision making process, allowing anyone who wants to be involved to have a chance to participate. In order to achieve this aim, MacRae (2011) suggests several changes for each level of government, including: deliberately broadening participation in advisory councils and bringing civil society organizations (CSOs) into governance models; creating national and provincial networks connecting local food policy councils; and undertaking joint programming with non-governmental organizations (NGOs).

8.4.5. Demand-supply coordination and self-reliance

Demand-supply coordination beyond simply market functions is needed to promote resource efficiency within the food system. Demand-supply coordination and the prioritization of self-reliance promote food systems that "…provide for as much of the biological requirements of the population as (is) possible within the physical constraints imposed by the Canadian climate and geology" (TFPC, 1994, p. 28). One mechanism for achieving demand-supply coordination is through supply-managed marketing boards, which provide legal mechanisms to adjust production to meet domestic consumption requirements. Most production is destined for the domestic market, with minimal import and export of those foods. Supply management is already in place for dairy products, chicken, turkey, and eggs in Canada. Canada does not export a large amount of its domestic strawberries, so supply management will have a more critical role in controlling the large volume of imports. MacRae (2011) notes that the key undertaking is to build on the

existing supply management model but with greater flexibility. He suggests several changes to enable this model, including: broadening governance structures, making it easier for new entrants, and diversifying scale but retaining emphasis on producer financial viability. Canada should extend the power of provincial produce marketing boards, currently generally quite weak, to include supply management authority. In Ontario, the Ontario Produce Marketing Association (OPMA) and the OBGA are candidates for this role; in Canada, the proposed Canadian Strawberry Promotion and Research Council (CSPRC) is likely. Supporting legislative changes are required to expand supply management, including modifying the *Farm Products Agency Act* and Farm Products Council of Canada and improving provincial agricultural land protection legislation and planning (MacRae, 2011). Self-reliance and support for local growers can also be prioritized through other means like transportation or energy taxes based on food miles, with the revenues of these taxes being redirected to waste prevention programming and infrastructure. These taxes would be applied indiscriminately across the supply chain and thus prevent protectionist challenges under current WTO and NAFTA trade agreements.

8.4.6. Establish effective producer associations

Producer associations should be established and strengthened in order to effectively advocate for the interests of local growers in public and private proceedings. In Ontario, the Ontario Berry Growers Association (OBGA) already exists and is the primary group that OMAFRA consults with when developing relevant policy and programming (OBGA, 2014). However, the interests of small-scale growers are unlikely to be fairly represented by the OBGA, as its membership represents less than a quarter of Ontario's strawberry growers (APFFQ, 2013). At the national level, there is currently an application to the Farm Products Council of Canada to establish the Canadian Strawberry Promotion and Research Council (CSPRC), an organization serving the entirety of Canadian production and imports. Funded by production and import levies, the CSPRC would support increased sales and distribution of domestic strawberries in season, and of imported strawberries the rest of the year (APFFQ, 2013). Unfortunately, the proposed CSPRC is facing significant opposition from other chain actors, specifically the Retail Council of Canada (RCC) and the California

Strawberry Council (CSC). RCC member importers include Canada's major grocery retail chains; while the CSC represents all of California's strawberry farmers, and approximately 75 shippers and processors. The RCC and CSC share similar arguments against the formation of the CSPRC, mainly that the CSPRC favours domestic producers. They argue that the CSPRC's levy-funded structure disproportionately imposes costs to foreign producers, importers, and retailers, and yet another cost to Canadian consumers. Furthermore, the proposed levy on imported strawberries constitutes a trade barrier and may violate Canada's international trade obligations under the WTO and NAFTA trade agreements. Lastly, they argue that the creation of an agency to support domestic production and export development is completely unnecessary; noting that consumer demand for domestic fresh strawberries already outpaces supply. Despite strong opposition to the creation of the CSPRC, the RCC and CSC maintain that they have positive relationships with local producers. The RCC notes that most retailers carry local strawberries throughout the growing season, while the CSC express that California and Canada share seasonal fresh fruit markets without competing with each other. In fact, the CSC adds that imported strawberries cause no harm to Canadian producers, and actually benefit Canadian producers by maintaining dedicated shelf-space and consumer awareness (McLinton, 2014; Christian, 2014).

The example of the OBGA highlights the need for representation of all Ontario strawberry growers in producer organizations. The OBGA and OMAFRA should communicate with growers in order to understand the barriers to their participation. Subsequently, appropriate measures should be implemented to increase representation of small-scale growers in both membership and consultation. The example of the CSPRC proposal highlights the difficulties in establishing a producer organization that essentially seeks to increase the power of local growers. While the RCC and CSC claim to support local growers, their response to the CSPRC application shows their unwillingness to share control of the supply chain. Imbalances advantage those in power and correspondingly it is in their interests to maintain the status quo (MacRae, 2011). To foster equitable supply chains, long-term, systemic changes to the structures, processes, and behaviours within the food system are needed. These changes lie beyond the scope of this discussion, however, this paper does suggest the development of collaborative private and public partnerships

in order to foster communication and begin this transition. In relation to the previous discussion on consumer education and food citizenship, consumers will also be more likely to advocate for equitable supply chains if they are aware of and able to engage with issues in the food system (Jaffe & Gertler, 2006).

8.4. Summary of suggested food waste strategies

This paper uses the ESR Framework to present a tiered approach for food waste prevention; suggested strategies are summarized in Table 10. Initial strategies seek to divert and reduce food waste while later stage strategies address the underlying causes driving its generation and normalization.

ESR Stage	Suggested strategies for change
Efficiency	▪ Increase and/or reallocate agricultural research funding for food waste research ▪ Consumer education campaigns ▪ Retailer efficiency strategies ▪ Facilitate redistribution and diversion ▪ Improve packaging options ▪ Equipment retrofit grants
Substitution	▪ Establish food waste reduction targets ▪ Conduct regular food waste audits and share results ▪ Promote communication and collaboration between chain actors ▪ Foster farmer cooperatives ▪ Increase access to organic waste diversion programs ▪ Implement government ceiling standards
Redesign	▪ Mandatory food waste reporting ▪ Introduce new government standards based on real quality standards ▪ Full cost pricing ▪ Enable informed and engaged consumer-citizens ▪ Demand-supply coordination and self-reliance ▪ Establish effective producer associations

Table 10: Summary of suggested efficiency, substitution, and redesign strategies for food waste prevention in Ontario's domestic fresh strawberry supply chain.

In order for redesign to be successful, food and agricultural systems must become a servant of food security policy (TFPC, 1994). Unfortunately, Canada has never had a coherent food policy that integrates relevant fields, such as agriculture, health, and social and economic development (MacRae, 2011). Rather, as MacRae (2011) notes, the current approach can be called *Canada's cheap food policy,* driven by the dominant view that the food system

should provide safe, high-quality food at reasonable prices. This study confirms how Canada's cheap food policy has tolerated, and even encouraged, the generation of such high levels of food waste. Likewise, trade liberalization priorities have steadily eroded the viability of Ontario's domestic strawberry industry. Local growers are also not confident in the government's commitment to helping them. As the owner of Knapp's Country Market and Nurseries states, "There's nothing we can do and the government doesn't seem to want to do anything to support growers. We should not have to be under the gun by big corporations" (Dharmarajah, 2011). A deep sense of mistrust between actors continues to hinder efforts to reduce food waste and foster larger food system changes. This paper asserts that the relative success of creating a joined-up food policy for Canada and achieving an ecologically sustainable, health-oriented, and equitable food system largely depends on political will and the commitment by actors to work collaboratively.

SECTION 9: CONCLUDING REMARKS

This study conducted a quantitative and qualitative analysis of food waste in Ontario's domestic fresh strawberry supply chain. Information synthesized from a review of comparable studies and contributions from supply chain actors was used to determine the occurrence and causes of waste in the chain. This study found that 56% of edible fresh strawberries grown in Ontario are wasted along the supply chain. Food waste is most prevalent among consumers, who generate 43% of all strawberry waste; and least prevalent at the retail stage of the supply chain, which generates only 13% of strawberry waste. Causes of food waste were categorized into biophysical factors, technical factors, mismanagement, regulatory factors, behavioural factors, and supplier-retailer relationships. However, as this paper has discussed, the generation of waste in one stage of the supply chain may be influenced by the actions or decisions of other chain actors. This study confirmed the work of Kohn (2011) and found that food retailers play significant roles in influencing waste generation up and downstream in the supply chain. The disproportionate amount of power held by food retailers is important for understanding why effective food waste reduction strategies have not yet been introduced. In particular, the high quality food standards imposed by food retailers onto suppliers explains why the

removal of Ontario's grading standards for fresh market commodities has had no perceived effects on reducing or mitigating food waste within the supply chain. Another significant observation found in this study is the widespread negative impacts of imported strawberries on the viability of Ontario's domestic strawberry industry. Supply chain actors expressed concerns over their inability to compete with the quantity and price offered by strawberry importers. These observations informed this paper's suggested short-, medium-, and long-term food waste strategies, organized according to the ESR Framework. Initial efficiency strategies broadly seek to increase the visibility of food waste as an issue and facilitate food waste diversion and donation. Following in the substitution and redesign stages, strategies becoming increasingly complex as they seek to address the underlying causes of food waste. Incremental strategies are recommended to induce the paradigmatic shifts needed to foster food systems that are environmentally sustainable, health-oriented, and just.

This study contributes to broader food waste and food security research for a number of reasons. First, although this case study is specific to Ontario's strawberry supply chain, similar patterns of food waste exist among industrialized countries, which allow this study's findings to be applied to analogous settings. Second, this study assists with both confirming and disproving food waste assumptions that are made in the literature. Mainly, this study demonstrates that government grading standards are not significant contributors to the generation of food waste, contrary to what has been suggested in previous studies. Third, this study contributes additional baseline data on food waste, which is noticeably absent for Canadian contexts.

The study of food waste adds complexity to discussions on both regional food systems and organic farming methods. Local food activists argue that regional food systems are more sustainable alternatives that also support the development of local economies. Similarly, organic farming methods are presented as more environmentally sustainable compared to conventional farming systems. However, to what extent are the environmental, financial, and social benefits of purchasing organic or locally grown food realized if it is ultimately wasted? The promotion of regional food systems, and thus the shortening of supply chains, does not necessarily equate to reductions in food waste. For example, due to differences in technology and resources, the percentage of waste

associated with selected types of Ontario's grown fruit were at least double that of imported fruit from California (Gooch et al., 2009). Regional food systems and organic farming systems are still preferable to conventional and long-distance food systems; however, concurrent efforts to reduce waste will maximize these advantages. Many argue that the cost of local and organic food is prohibitive, limiting access for lower income individuals. Yet, as some scholars suggest, individuals can redirect the money saved from wasting less food to purchase foods that support regional and sustainable food systems (Martin, 2012).

Reducing food waste is attractive to policy makers, representing low hanging fruit for increasing the availability of food and increasing resource efficiency. However, the issue of food waste is much more complex and significant knowledge gaps among researchers and policy makers limit the development of effective reduction and prevention strategies. Policy makers introduce strategies that often conceptualize food waste as its own problem, warranting only technical approaches for its management. Moving forward, food waste must be understood as both a symptom of, and contributor to, larger systemic issues within the dominant food system. Effective approaches to reducing food waste and reducing food insecurity will not occur until governments abandon their current cheap food policy frameworks. North American and European governments continue to prioritize high yield paradigms and support conventional agricultural methods, which create significant negative pressures on the environment and individual livelihoods (Holt-Giménez, 2012). The continued prioritization of livestock and biofuels, in addition to the extraordinary amounts of food being wasted, has allowed widespread hunger and malnutrition to persist even as the world produces surplus food. The recent World Food Crisis of 2008 revealed the contradictions found within the dominant food system. While many of the world's vulnerable were unable to afford the rising cost of food staples, elsewhere in the world, over a billion tons of edible food was wasted. Hunger is caused by poverty and inequality, not scarcity (*ibid)*. In a food system that is tolerant of inefficiency and waste, a shift is needed encompassing producers, retailers, consumers, and all actors in between. The FAO's call for increased agricultural production is only one part of an approach to ending hunger and meeting future global food needs. Similarly, the reduction of food waste is only one part of a larger transformation towards a food system that is ecologically sustainable,

health-oriented, and equitable. Ideally, governments should foster a joined-up policy approach that is coherent, transparent, and comprehensive and that aligns with the goals of this food system (MacRae, 2011). Wasted food represents lost opportunities to feed vulnerable citizens, which is especially a concern for developing countries facing rapid population growth and urbanization. Given the negative financial, environmental, and social impacts associated with food waste, effective reduction and prevention strategies are worth pursuing.

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APPENDIX 1: PRODUCER SURVEY TEMPLATE

FOOD WASTE SURVEY FOR ONTARIO'S FRESH STRAWBERRY SUPPLY CHAIN (PRODUCER)

Data collection for the Major Research Paper, "An analysis of food waste in Ontario's fresh strawberry supply chain", by Anne Siu in fulfillment for her Master of Environmental Studies degree at York University.

Company (optional) and location:	Date:	
Name (optional):	E-mail (optional):	Telephone (optional):
Title and responsibility (optional):		

SECTION 1: COMPANY OVERVIEW (5 questions)

Question 1: What is your company's role in Ontario's fresh strawberry supply chain (please bold or circle)?:
- Grower/packer
- Importer/packer
- Food manufacturer
- Logistics/Storage provider
- Wholesaler
- Retailer
- Other: _____

Question 2: On average, what is your company's total marketed production volume of fresh strawberries per year?

Question 3: What is the amount of your sales per year (roughly) for this product in Ontario?

Question 4: What is your market share in Ontario for this product (please bold or circle)?
- Less than 5%
- Between 6% and 25%
- Between 26% and 50%
- More than 50%
- I'm not sure

Question 5: What percentage of your fresh strawberries are sold via:
- _____ Customer U-Pick
- _____ Farm stand (pre-picked)
- _____ Community-supported Agriculture (CSA) programs
- _____ Wholesale distributors
- _____ Direct to food retail
- _____ Other (please specify):

SECTION 2: OCCURRENCE OF FOOD WASTE (3 questions)

Question 1: In this survey, food waste is defined as the mass or volume of edible food lost or wasted in the part of food chains leading to human consumption. What is your best estimate of the percentage of food waste for fresh strawberries in your operation in the course of one year (typical min./max. range)?

Question 2: Please use the following scale to indicate the accuracy of your answer to Question 1. Number one on the scale indicates that your answer is a best guess based on experience, not measured data. Number five indicates that your answer is based on some measured data. Number ten means that your answer is based on actual measures that are believed to be very accurate.

Please bold one number: 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

Question 3: Are there any specific cycle periods of your products' food waste during the year?

SECTION 3: DESTINATION OF FOOD WASTE (2 questions)

Question 1: What happens to food waste of downgraded and/or damaged strawberries (secondary usage)?

Question 2: What happens to strawberries that exceed the proportion of shelf life demanded by retailers but is still safe to eat?

SECTION 4: CAUSES OF FOOD WASTE (2 questions)

Question 1: What do you think are the main causes of food waste in your operation?

Question 2: What do you think are the main causes of food waste throughout the fresh strawberry supply chain as a whole?

SECTION 5: FOOD WASTE POLICY (3 questions)

Question 1a: Effective July 1, 2011, Ontario eliminated grading standards for fresh strawberries grown and sold in the province. Based on your experience, has the elimination of produce grading standards had any effect on the generation of food waste in your operation? Why or why not?

Question 1b: As a whole, do you think the elimination of produce grading standards has made it easier, more challenging, or had no effect in reducing food waste within Ontario's fresh strawberry supply chain. Why or why not?

Question 2: Are there any current policies that you consider barriers to reducing food waste in your operation?

Question 3: In order to be most effective for reducing food waste, where do you think food waste reduction policies should be prioritized along Ontario's fresh strawberry supply chain…?
      a. In the short term (within the next 5 years):
      b. In the long term:

SECTION 6: ADDITIONAL COMMENTS

Please feel free to write down any additional comments regarding food waste in Ontario's fresh strawberry supply chain.

Thank you!

APPENDIX 2: RETAILER SURVEY TEMPLATE

FOOD WASTE SURVEY FOR ONTARIO'S FRESH STRAWBERRY SUPPLY CHAIN
(RETAILER)

Data collection for the Major Research Paper, "An analysis of food waste in Ontario's fresh strawberry supply chain", by Anne Siu in fulfillment for her Master of Environmental Studies degree at York University.

Company (optional) and location:	Date:	
Name (optional):	E-mail (optional):	Telephone (optional):
Title and responsibility (optional):		

SECTION 1: COMPANY OVERVIEW (5 questions)

Question 1: What is your company's role in Ontario's fresh strawberry supply chain (please bold all that apply)?:

- Grower/packer
- Importer/packer
- Food manufacturer
- Logistics/Storage provider
- Wholesaler
- Retailer
- Other: _____

Question 2: What is the estimated amount of sales per year for fresh strawberries in your Ontario stores?

Question 3: During peak season (late spring to early summer), approximately what percentage of fresh strawberries sold in your stores is grown in Ontario?

Question 4: What is the primary channel used for purchasing fresh Ontario strawberries for your operation (ex. directly from producers, wholesalers, etc.)?

Question 5: What is the product shelf life (days) (total and from Regional Distribution Centre) for Ontario-grown strawberries?

SECTION 2: OCCURRENCE OF FOOD WASTE (3 questions)

Question 1: In this survey, food waste is defined as the mass or volume of edible food lost or wasted in the part of food chains leading to human consumption. What is your best estimate of the percentage of food waste for fresh strawberries in your operation in the course of one year (typical min./max. range)?
   a. Imported strawberries:
   b. Ontario strawberries:

Question 2: Please use the following scale to indicate the accuracy of your answer to Question 1. Number one on the scale indicates that your answer is a best guess based on experience, not measured data. Number five indicates that your answer is based on some measured data. Number ten means that your answer is based on actual measures that are believed to be very accurate.
   Please bold one number: 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

Question 3: Are there any specific cycle periods of your products' food waste during the year?

SECTION 3: DESTINATION OF FOOD WASTE (2 questions)

Question 1: What happens to food waste of damaged strawberries (secondary usage)?

Question 2: What happens to strawberries that exceeds shelf life, but is still safe to eat?

SECTION 4: CAUSES OF FOOD WASTE (2 questions)

Question 1: What do you think are the main causes of food waste in your operation in regard to both local and imported fresh strawberries?

Question 2: What do you think are the main causes of food waste throughout Ontario's fresh strawberry supply chain as a whole?

SECTION 5: FOOD WASTE POLICY   (3 questions)

Question 1: Effective July 1, 2011, Ontario eliminated grading standards for fresh strawberries grown and sold in the province. Based on your experience, has the elimination of produce grading standards had any effect on the generation of food waste in your operation, or Ontario's fresh strawberry supply chain as a whole? Why or why not?

Question 2: Are there any current policies that you consider barriers to either reducing food waste in your operation or to donating more unsaleable product?

Question 3: In order to be most effective for reducing food waste, where do you think food waste reduction policies should be prioritized along Ontario's fresh strawberry supply chain…?
        a. In the short term (within the next 5 years):
        b. In the long term:

SECTION 6: ADDITIONAL COMMENTS

Please feel free to write down any additional comments regarding food waste in Ontario's fresh strawberry supply chain.

Thank you!

APPENDIX 3: FEDERAL GRADES AND STANDARDS FOR FRESH STRAWBERRIES

Source: SOR/94-718, s. 9.; Reg. 285 Fresh Fruit and Vegetable Regulations; Canada Agricultural Products Act, 1985.

Application
- **83.** The grade and the standards set out in sections 84 and 85 apply to strawberries of varieties grown from the genus*Fragaria*.
- SOR/94-718, s. 9.

Grade and Grade Name
- **84.** (1) The grade and grade name for strawberries is Canada No. 1. (2) The use of the grade and grade name set out in subsection (1) is optional but, where they are used, the fruit shall conform to the standards set out in section 85.
- SOR/94-718, s. 9.

Standards
- **85.** Subject to the general tolerances set out in section 86, strawberries graded Canada No. 1 shall
  - (*a*) be properly packed;
  - (*b*) be fairly clean, firm and sound;
  - (*c*) be well formed and have the calyx attached;
  - (*d*) be of a colour characteristic of the variety when mature;
  - (*e*) have a minimum diameter of 16 mm (5/8 inch);
  - (*f*) be free from bird pecks and bruises;
  - (*g*) be free from mould and surface moisture; and
  - (*h*) be free from any other damage or defect or combination thereof that materially affects the appearance, edibility or shipping quality of the strawberries.
- SOR/94-718, s. 9.

General Tolerances
- **86.** (1) In the grading of strawberries, the standards set out in section 85 are considered to be met where
  - (*a*) up to 10 per cent by count of the strawberries in a lot inspected at the time of shipping or repacking have defects, including not more than
    - (i) two per cent that are affected by decay, and
    - (ii) five per cent that have the same defect other than decay;
  - (*b*) up to 10 per cent by count of the strawberries in a lot of strawberries inspected at a time other than at the time of shipping or repacking have defects, including not more than five per cent that have the same permanent defect; and
  - (*c*) in either of the cases referred to in paragraphs (*a*) and (*b*), up to five per cent by count of the strawberries in the lot have less than the minimum diameter set out in paragraph 85(*e*).
- (2) Condition defects shall apply against the grade of a lot of strawberries only when the lot is inspected at the time of shipping or repacking.
- SOR/94-718, s. 9.