Exploration into Food Waste Occurring in Bovine Dairy, Leafy Green and Apple Supply Chains

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A Thesis
Presented to
The University of Guelph

In partial fulfillment of requirements
for the degree of
Doctor of Philosophy
in
Management

Guelph, Ontario, Canada
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ABSTRACT

EXPLORATION INTO FOOD WASTE OCCURRING IN BOVINE DAIRY, LEAFY GREEN AND APPLE SUPPLY CHAINS

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Food waste is an issue of significant importance and rising concern in society. While research indicates that the majority of food waste is occurring in consumers' homes, there is also considerable waste generated in food supply chains. Waste reduction in food supply chains represents a potentially rewarding challenge for researchers as it can reduce the environmental impact of the food system, but also because companies continually seek out money saving opportunities. In this dissertation, food waste and management literature are examined. The theory of the offering, is used to describe moving from a supply chain to a value chain. It is suggested that this will force increased valuation of food items which will help reduce waste. The concept of the bullwhip effect is also presented and the idea that it may be contributing to waste generation is introduced. Three case studies examining bovine dairy, leafy greens, and apple supply chains are used to describe where, how, and why food waste is occurring. This exploratory work of case studies produces twenty testable hypotheses to direct future research. These hypotheses are mapped onto a framework indicating where waste can be found in food supply chains suggesting what areas of the supply chain is best suited for additional research.
ACKNOWLEDGEMENTS

The completion of this research would not have been possible without the willingness of many individuals in food supply chains, primarily in Ontario but also as far away as New Zealand, to donate their time and share their experience and knowledge with me. Their willingness to participate is particularly appreciated due to the sensitive nature of the research subject matter. I appreciate the willingness and interest of these individuals. It is because of people like these, that are engaged and striving for the betterment of their industry and their society, that we are able to grow our knowledge and improve our surroundings.

My advisor, Dr. Michael von Massow has been a great support in this process. His engagement in the issue and his openness to discuss new ideas have provided many useful insights and helped spur the research process. Furthermore, his ability to command a room and deliver complex or dry material in the most engaging manner will always be a source of inspiration for me. It was his excellent speaking skills that motivated me, while a Master’s student, to pursue doctoral studies, and his use of a chain to describe how to motivate supply chain change has stuck with me ever since.

My committee Dr. May Aung, Dr. Ralph Martin, and Dr. Kate Parizeau have been great supporters in this process. It was conversations with Dr. Martin early on that also helped direct me to doctoral studies. Dr. Parizeau and Dr. Aung have offered excellent perspectives that have challenged and expanded my research in useful and informative ways and I am very grateful for that.

To my colleagues and friends that I have made in my and other PhD management cohorts. I appreciate the time and work we shared together. The variety of research and life backgrounds provided an engaging space to be part of and I am thankful for it.

To my family and friends that have been an endless source of support and resources, I sincerely appreciate it. Many of you were willing to have long conversations and debate with me about important issues. Some provided excellent research contacts or participated themselves and I am eternally grateful for the engaged and passionate group of individuals I get to share my time with.

Finally, to my spouse, Matthew Pym – your patience in my long period as a student has been appreciated immensely. Your willingness to accommodate my schooling, even in the midst of stressful house renovations reveals something special about your character. The way you entertain and engage in any debate on my research that I bring up has allowed me to develop some very nascent ideas. I am forever grateful for your patience, thoughtfulness and willingness to have a good debate whenever required.
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Chapter 1 – Introduction

1.1 Study Motivation

The Food and Agriculture Organization (FAO) of the United Nations (UN) reports that the number of undernourished and food insecure people has risen since 2015 from 777 million to 815 million (FAO et al., 2017). Our ability to produce food is being impacted by soil erosion which threatens crop productivity (Reeves, 2017), climate change (Springmann et al., 2016), loss of farmland due to urbanization, and an expanding human population (Seto, & Ramankutty, 2016). Furthermore, the world population is predicted to reach 9.8 billion by 2050 (UN, 2017) meaning requirements for food will continue to rise along with stressors that make food production difficult.

Although the desire for increased food production is a popular discussion with some researchers, consideration of which food items are being wasted is also important. It is estimated that an average of one third of the food produced is wasted and this number ranges based on the product type, from 10 to 50% (Parfitt, Barthel & Macnaughton, 2010). In developed nations such as Canada, waste typically occurs closer to the consumer end of the supply chain due to issues of esthetics and overabundance (Godfray et al., 2010).

In order to tackle the problem of food waste, there is a need to understand the social and structural context within which the problem exists. It is necessary to understand the whole food system and the social context which it is situated. This system has become highly interconnected with a variety of complex relationships, virtual networks, and alliances formed via horizontal and vertical
cooperation, forward and backward integration. It is marked by continuous innovation (Van Der Vorst, 2006). The complexity of the system is, in part, necessary to allow certain efficiencies that make it possible to supply large amounts of relatively cheap food to many. In developed nations like Canada and the United States supply chains are tasked with being not only the purveyors of food products but also the protectors and developers of the land and technology required to meet the food needs of developed society.

Food supply chain participants have traditionally been inward focused and myopic in terms of focusing on producing profit now over maintaining the resources needed to produce products and profit in the future. Recent discussion about high levels of food waste and the negative implications associated with waste has caused conversations among interested individuals and groups.

Efforts to are beginning to be made by some to reduce food waste through many small and some large programs, including the sale of ugly produce at the Intermarché supermarket chain and through Loblaw’s Naturally Imperfect line of produce. These initiatives ask supply chains to move visually unappealing produce to the consumer end of the chain for consumption instead of processing these products or disposing of them. The level of impact this is having is debatable and requires further research. More investigation is required to understand this practice and the impact of other small-scale activities, as well as the impact of all these things on waste further up the supply chain. There is also a fundamental lack of understanding of both the volumes and sources of waste in
food supply chains. Such an understanding is critical in order to effectively begin evaluating approaches to reduction.

1.2 Research Problem

In their 2014 paper Papargyropoulou et al. suggest that the food supply chain is the best place to tackle the issue of food waste because the scale of the waste means that reduction could result in significant savings to be passed on to consumers and thus help alleviate some food insecurity. The Environmental Protection Agency (EPA) in the US also echo’s this sentiment and encourages food supply chains to reduce their waste in order to produce lower cost food items (2012). Despite this there are several problems that inhibit effective action associated with solving the issue of food waste in supply chains. These issues are varied and described in diverse ways within the literature. The following list represents a synthesis of the key problems described.

1. The scale and volume of food waste is not well understood (Parfitt, Barthel, & Macnaughton, 2010).

2. A clear, universal definition of food waste that covers legal, academic, and public understanding has not been agreed upon (Gustavsson et al, 2011; Partfitt, Barthel, & Macnaughton, 2010; Thyberg & Tonjes, 2016).

3. Efficient tactics to deal with the waste that is identified are not always clearly elucidated or economically described (Rutten, 2013).
4. There is a lack of holistic approaches to food waste reduction and a lack of documentation of the locations of waste generation (Papargyropoulou et al., 2014).

5. Waste generation varies based on multiple factors including the type of food supply chains, location in any given food supply chain, economic status of the food supply chain participants, and the geographical location in which the food supply chain is located (Garrone, Melancini, & Perego, 2014; Parfitt, Barthel, & Macnaughton, 2010).

Research into the food waste issue is still in its infancy and more work is required to contribute to the discussion. Early stage investigations can benefit from research that collects both quantitative data as well as qualitative data. Qualitative data, can provide rich, contextual data. In addition to this, qualitative data can help direct additional detailed quantitative data collection which can be useful for producing generalizable findings.

Qualitative data collection can also provide contextual understanding of a particular social situation or phenomenon. When qualitative and quantitative data are combined in case study research it provides the opportunity to understand complex social phenomena while maintaining a holistic, real world perspective (Yin, 2014). This type of research is well suited to address the five factors posed above.
1.3 Research Purpose and Question

The goal of this research is to provide contextual information about food waste occurring in certain supply chains. Specifically, the objective is:

To develop a framework that can contribute to understanding where, why, and how waste occurs in food supply chains and how management systems and common practices impact waste production.

The information gathered as part of this research will be presented to generate hypotheses that can lead to further research and investigations in other supply chains. This will allow for additional functional application of the findings beyond the food supply chains examined. The findings will be situated within the context of the management and food waste academic literature and seek to build on the understanding available in these disciplines.

The ultimate research question investigated for this dissertation is:

Where and why does food waste occur in dairy, leafy green, and apple food supply chains in Ontario, Canada, and how do supply chain factors impact the production of food waste?

This will be investigated by developing a deep understanding of several food supply chains, determining areas and reasons for food waste and finally, analyzing and applying management theory and concepts to create a structured understanding of the issues and how they might be resolved.
1.4 Literature Review

Because the issue of food waste inherently touches so many aspects of society, this research draws on multiple spheres of understanding from the academic literature as well as from government and industry publications. The literature review section pulls from general food waste literature as well as supply chain management, service management, and stakeholder theory literature to create an understanding of the issues in supply chains as well as presenting an area where new data could be useful to build a functional understanding of the issue and its context.

1.5 Research Context

The data for this investigation is gathered from food supply chain participants in Ontario, Canada. Food and agriculture make up a significant portion of Ontario’s economy. It is suggested that one in eight jobs in the province are linked to agriculture and food (AAFC, 2017a). In addition, $111.9 billion in economic contributions are tied to the sector (AAFC, 2017b). Because of the economic value and impact of this industry it is met with significant research and attention focusing on increasing efficiency and production. Strategies to reduce food waste in this sector would be a useful and logical contribution.

Canada enjoys a status as a developed nation, with per capita GDP ranking of 14th in the world (OECD, 2017). Despite this, problems with food insecurity and unequal resource distribution are present. It is estimated that one
in eight households experience food insecurity in Canada with the northern most regions in general and many indigenous communities in particular experiencing the issue at disproportional levels. Furthermore, many large Canadian cities experience the problem of food deserts, where food is not readily available for the local population (PROOF, 2017). These issues exist despite relative wealth and abundance.

Unequal distribution of resources and clear need are drivers of research and development in many areas. This is beginning to be addressed in policy and legislation such as in the *Waste Free Ontario Act*, which seeks to prevent edible food from moving to landfills. Despite positive steps, more research is needed to develop effective tools and strategies to reduce food waste further. The research presented in this dissertation is positioned to provide input that will assist in food waste reduction in food supply chains in the hopes that this will allow decreased food costs to be delivered to the most vulnerable in Canadian society, along with generally improving the sustainability of food supply chains.

1.6 Dissertation Structure

This dissertation is laid out using a linear-analytic structure as described by Yin (2014). A literature review is presented first, to provide context for the data collected in the case studies. Also, a methods section is offered following the literature review to describe the data collection process as well as the philosophical basis that informs the research. Following this, an analysis of three case studies from three separate supply chains are presented, as well as an
analysis of a synthesis case which makes comparisons across all three supply chains. Finally, a discussion section concludes the dissertation by presenting a framework with the key results, a discussion and application of these results in industry and government policy, limitations of the research, and presents hypotheses generated to indicate avenues for future research. The contents of this dissertation provide evidence and discussion, that, if considered and applied, can contribute to the reduction of food waste in food supply chains in Ontario, Canada, and other nations.
Chapter 2 – Literature Review

2.1 Introduction

The purpose of this chapter is to review academic literature on supply and value chain management, organizational management, and service management – specifically pertaining to how key concepts in these fields impact food waste in food supply and value chains. All these areas of study inform and open the door for the questions posed and investigated in this dissertation.

There has been increasing popular interest in the issue of food waste. The topic has been tackled from many different academic angles. Traditionally many perspectives are fairly narrow in their focus and stay true to the academic silo of any particular researcher. For example, it is common to find engineering literature that looks at food waste focused on creating biogases or looking at isolating volatile compounds for energy generation (Kondusamy & Kalamdhad, 2014; Lee, Chua, Yoeh, & Ngoh, 2014; Paramaguru, Kanna, & Lawrence, 2017). Similarly, agricultural research typically focuses on failures in production and how to reduce yield gaps for increased food production (Snyder, Miththapala, Sommer, & Braslow, 2017). There is a clear need for these types of research, but more can be done to bring distinct fields together to create a more holistic perspective of the issue of food waste. Some fields of research naturally take a wider perspective. Sociological research looking at food waste inherently includes many perspectives – a recent investigation exemplified this by identifying the different types of food systems that currently exist and their impact on food waste from a global perspective (Lawrence, 2017).
In 2018 a team of agricultural and management scholars produced a paper calling for more multidisciplinary research on food waste, specifically noting the value of the holistic perspective offered by food supply chain research (Alamar, Falagán, Aktas, & Terry). Investigations at the food supply chain level also naturally include many perspectives. In order to evaluate waste that is occurring along a supply chain, researchers need to understand and consider many external factors that impact each unique supply chain step. This provides the opportunity to view food waste as a multi-perspective, complex issue which can produce novel insight into specific areas of waste and inefficiency.

The research in this document uses management theories as the framework to connect research from many relevant spheres that investigate food waste. This chapter compiles academic literature with business and management focuses, as well as research from other academic areas. Furthermore, industry and government data are used throughout the paper to supplement and support the discussion. These sources are used to fully scope the problem and pose relevant and useful management solutions that consider multiple aspects of the issue.

The remainder of this chapter will be divided into specific sections looking at (2.2) supply chain management literature, (2.3) understanding food waste, (2.4) a synthesis section that brings these topics together to pose useful questions about the nature of food waste in food supply chains, (2.5) a conceptual framework, (2.7) a discussion of the application of stakeholder theory, and finally (2.8) a summary of the literature and conceptual framework.
2.2 Supply Chain Management

Companies are becoming increasingly global and compete heavily on the basis of speed and quality. This means that supply chain management strategies that can improve speed and quality provide a necessary edge for improving a businesses’ competitiveness. Supply chain management is a complex field and can be defined in various ways and according to an individual’s frame of reference. Defining supply chain management as a term is important to facilitate clear communication of the research presented here. For this research supply chain management will be defined as the strategic coordination of business functions, relationships, and tactics between three or more businesses connected to the movement of products, services, finances, and/or information, for the improvement of the whole system (Mentzer et al., 2001).

Many supply chain management practitioners and researcher would posit that a supply chain is functioning well when the end user is unaware of much of the complexity and integration required to make it function well. Instead the end user should only experience the supply chain’s effect – receiving a desired item in good condition and in a timely manner (Lu & Swaminathan, 2015). Supply chain management has evolved to this point, from its inception in the mid-1980s. It is a term that now encompasses procurement, demand forecasting, distribution, and service, and approaches these functions from multiple perspectives. It uses multiple perspectives to ensure that the customer at the end of the chain receives the product with maximal efficiency.
Supply chain management for food supply chains offers some specific challenges. Food items are inherently vulnerable to damage such as bruising and pests and have limited shelf lives, which is the subject of research looking at cold chain maintenance and optimal temperature achievement for maximum product durability (Aung & Chang, 2014). Food products are also often sensitive to handling damage which has resulted in supply chains developing packaging strategies to combat this as well as using packaging to provide promotions, product information, convenience, and waste reduction through increased shelf-lives (Verghese, Lewis, Lockrey, & Williams, 2015). Food supply chain management has created many solutions to decrease food waste but evidence indicating the presence of high levels of waste is still available (Alamar et al., 2018; Bloom, 2011; Parfitt, Barthel, & Macnaughton, 2010) and suggests the need to do more.

In general, there are multiple perspectives that can be used to influence supply chain management. Because of the increasing complexity of the systems practitioners need to be open and receptive to incorporating new tactics and ideas (Melnyk, Davis, Spekman, & Sandor, 2012). A failure to understand the needs of the customer and the goods, as well as a failure to react appropriately to change can result in lost business or lost opportunity to create business. Supply chain participants must be actively engaged and look for new tactics that go beyond expense reduction. They need to seek opportunities to add value to their end products in order to provide a more appealing item at each step of the chain and most importantly, to the end consumer (Smart, 2006).
One phenomenon that is evident in the supply chain literature that potentially contributes to waste within the supply chain, is the bullwhip effect. The idea of the bullwhip effect was developed in the early 1990s to describe a phenomenon observed with diaper supply by Proctor & Gamble executives (Lee, Padmanabhan, & Whang, 1997). The phenomenon observed is the amplification of apparent demand down the supply chain despite actual demand remaining constant. This distorted information is intensified and creates growing inefficiencies as it moves down the supply chain. A common example used to describe the phenomenon is the changing demand for children’s diapers as a result of a sale offered at a large retail outlet. In this example, a store puts children’s diapers on sale, marking them as a loss-leader\(^1\) to draw consumers in. This sale results in an increased demand for diapers and causes the store to increase its orders from suppliers. Suppliers do not realize/were not made aware that diapers are being put on sale in this store and are forced to short orders for other stores to cover the apparent increase in demand at the large retailer offering the sale. Meanwhile other stores that are provided for by the suppliers are short-stocked and respond by increasing their orders to cover their now expected deficit. The suppliers increase their orders from the manufacturer to cover the increased number of orders coming from their stores. The manufacturer then has an experience similar to the supplier where they are required to short change some orders to meet as much demand as possible from

\(^1\)A product or service offered for sale by an organization at a loss in order to attract customers (Law, 2016).
specific customers. Manufactures then experience increased orders by suppliers looking to hedge their bets against shortages. This results in the manufacturer increasing demand from their raw goods suppliers. The production of raw goods ramps up and eventually the whole supply chain is producing more diapers. By this time inevitably the diaper sale at the large retailer has ended and demand stabilizes, or even decreases due to stockpiles of sale diapers in consumer’s homes. This results in a costly surplus of inventory along the whole supply chain.

With a non-perishable good such as diapers, this activity can cause supply chain upset resulting in decreased efficiency. Similarly, when this scenario occurs in a food supply chain it may result in excess inventory and inefficiency with the added issue of food waste. Increased food waste may occur due to the stockpile of goods in consumers’ homes as well as having a new surplus throughout the supply chain that can end up wasted if demand is not high enough to move it to consumers before it degrades.

When the bullwhip effect is present in a food supply chain there is potential that food waste occurs due to the inability to store many food items for long periods of time. The presence of the bullwhip effect has been documented in many supply chains (Akkermans, & Vos, 2003; Ravichandran, 2008), but it has not been observed to impact waste in food supply chains. It is possible that there is a feature unique to food supply chains that makes this issue absent, but it is also possible that the research to identify it has not yet been attempted. This represents a clear gap in the literature.
Importantly, research is available that shows the bullwhip effect can be controlled. In 2003 scholars found that although they could not entirely eliminate the impact of the bullwhip effect in order-up-to and smoothing style supply chains, they could reduce its impact by ensuring that all parties participated in enhanced information sharing (Dejonckheere et al.). Similarly, other researchers have found that by sharing inventory information throughout the supply chain the bullwhip effect is minimized (Croson, & Donohue, 2005). Finally, a more recent review of the literature on mitigating the effects of the bullwhip found that most articles suggest some form of improved communication (de Almeida et al., 2015).

### 2.2.2 Service Dominant Logic and the Offering

Service dominant logic is a unique way to approach supply chain management and add value for customers. This concept necessitates taking a holistic view of business practices to determine how they impact the organization, market, and society, while realizing that all exchanges are fundamentally service exchanges (Vargo, Lusch, & Akaka, 2010).

The use of service-based logics in various disciplines has evolved as service focused research has grown. This growth began in the 20th century when economic data indicated the high revenue driving potential of service activities (Fisk, 2010, p. 645). Grönroos, a key contributor to service management research, describes service as a perspective rather than one area of study (Grönroos, 1994). This early description is useful when considering service dominant logic. Taking the perspective of service in all activities is at the core of
service dominant logic; it dictates that we reframe the economic activities of society from goods focused to service focused (Vargo & Lusch, 2006).

Reframing supply chain management to include this perspective can provide a novel competitive edge. This reframing of supply chain management to include a service dominant logic perspective is easier when considering the concept of the offering. The offering describes the entity that is a service and a product interwoven as one synergistic entity. This moves the supply chain from a transactional focus to one with greater communication and a focus on creating mutual value in the relationship.

The offering is used to convey that a service is not just the intangible part of a sale; it is indivisibly intermingled with the product (Johns, 1999). It is the concept that one component cannot be separated from the other and it truly exemplifies the nature of the changing economy. Products no longer exist as singular and simple entities. Customers demand value added to their product and this cannot be accomplished through implementing the traditional concept of service: an employee at the end of the supply chain provided to answer questions. Instead the changing economy requires inputs of value along the supply chain to provide a final product that includes many intangible services.

This idea can be easily applied to food supply chains. Consumers do not simply buy cheddar cheese, for example, they also purchase an experience with the cheese. Intangible features such as assortment and presentation in the store (Briesch, Chintagunta, & Fox, 2009), packaging (Briesch et al., 2009; Silayoi & Speece, 2004), organic production status or animal welfare considerations
(Megicks, Memery, & Williams, 2008), or if it is locally produced (Bauer, Heinrich, & Schäfer, 2013) has the potential to influence purchase decisions. The combination of these factors, and many more, create the offering. Applying techniques in the food supply chain that reduce food waste and therefore increase food sustainability can add value to food products and create a better offering.

Throughout the development of service dominant logic there have been advocates for a change in perspective from the goods centered view of business to a service centered view. This view of the market refocuses supply chains to be truly customer centric by turning tangible goods into a means to deliver services (Vargo & Lusch, 2004a). A service view of the economy identifies the service factors that the customer is looking to receive through the purchase of the product and then strives to provide the service factors with the product delivery. This dissertation presents evidence and discussion around the sale of food products and discusses how the concept of the offering can create a more value laden product to enhance the functioning of food supply chains and reduce food waste.

The work of von Massow and Canbolat suggests that firms must make value added strategy decisions based on a clearly defined plan and understanding of the issue (2014). In the case of food waste an understanding of the impact it has on society and the environment as well as the value food from a waste reduced food supply chain holds for consumers should be evaluated. Furthermore, there may also be financial value for supply chain participants. This
knowledge will facilitate action and change in food supply chain operations. Furthermore, although the value of the offering from a waste reduced supply chain will be intrinsically different for each consumer and also supply chain participants, it can be argued that the extrinsic value of food waste reduction remains intact and provides a level of intangible value. Therefore, an investigation into the consumer related value of reduced food waste serves as useful not only for labeling and as a tactic to increase sales, but also to improve the social and environmental responsibility of the supply chain – an issue of increasing concern (Pishvaee, Razmi, & Torabi, 2012).

Developing a plan that incorporates the different strengths of each supply chain partner is a necessary step to integrate new strategies. Different supply chain partners have different strengths and capabilities ranging from flexibility (Gosling, Purvis, & Naim, 2010; Tachizawa & Giménez, 2009), improvisation (Pavlou & El Sawy, 2010), capacity, credit terms, environmental performance (L. Y. Lu, Wu, & Kuo, 2007), and many others. When taking a holistic approach to food waste in the supply chain an understanding of each participant’s strengths and weaknesses and needs must be determined in order to develop an understanding of the issue of waste so that an effective plan for waste reduction can be developed and successfully implemented.

The idea of the offering can also be extended further to include additional elements of the food supply chain. Service dominant logic dictates that specialized skills and knowledge, not goods, are the basis of economic exchange (Lusch & Vargo, 2006, p. 43). This means that all forms of exchange, whether or
not goods are involved, constitute service because knowledge and skills are required. This is a very useful and clear description that refocuses any discussion of goods to include a more complete perspective of what was required to produce them. Furthermore, in their seminal service dominant logic paper, Vargo and Lusch reference Gummesson’s (1994) description of the offering and describe it as the way of the future where customers purchase a value added product that is a combination of a good and a service and these things can no longer be seen as divisible (2004).

2.2.3 Value Chain Management

When the concept of the offering, as described by service dominant logic, as well as the values associated with the sustainable supply chain are applied to supply chain management research we can move the discussion of a supply chain to one about a value chain. Value chains represent a shift in thinking from an interconnected group of companies that work individually to move products, goods, or services to end users, to a group of interconnected businesses that work together with a clear emphasis on cooperation and collaboration (Al-Mudimigh, Zairi, & Ahmed, 2004).

The concept of value chain management inherently encompasses the idea of the offering as it refocuses activities from individual focused to a more holistic, wider focus on the implications individual activities have on the whole unit. A key recognition any offering requires is that companies place the customers at the core of their business mission. According to foundational premise ten of service
dominant logic, value is always uniquely and phenomenologically determined by the system’s beneficiaries (Lusch, 2011). This means that the ultimate goal of food supply chains should be to benefit members of society because all members of society are beneficiaries of food supply chains. In order to truly work to satisfy the consumer, businesses need to refocus the activities of many of their departments in order to create a natural focus on providing the best offering.

Despite the effort required for this change, the shift has the potential to positively impact not only customers, but also society at large. This means that the discussion of stakeholders, in the application of service dominant logic, can increase the positive potential impact of a business on society (Vargo, 2011). Therefore, it is conceivable that service dominant logic can reorient businesses for lasting and measurable positive impact.

It has been suggested that managers should shift focus:

1. From the product-based utility to total utility in the customer relationship.
2. From short-term transactions to long-term relationships.
3. From core product (goods or services) quality or the mere technical quality of the outcome to total customer-perceived quality in enduring customer relationships.
4. From production of the technical quality of products (goods or services) as the key process in the organization to developing and managing total utility and total quality as the key process. (Grönroos, 1994)
This consideration also includes the ideals of sustainable supply chain management, as described in section 2.2.4, and value chain management that looks at producing supply chains that are environmentally responsible as well as socially responsible, providing an offering through a system that has an overall positive impact. Therefore, the systems to move products, services, finances, and/or information in this research will be discussed with the ultimate goal of achieving value chains that takes a service dominant logic perspective and that views the movement of the offering from business-to-business, as a way to add value at each step.

The remainder of this research will use the terms supply chain and value chain with clear distinction and purpose in an effort to emphasize the factors that should be used by businesses to create a better offering and a more sustainable system. The term supply chain will be used when referring to the status quo in operations that moves products from farm to consumer. The term value chain will be used to highlight positive steps that have been taken or will be taken to produce a better offering, in line with the tenants of service dominant logic. It is important to note that although the term value chain will imply the implementation of positive steps, it should not be taken as a signal that no more improvements are need. More specifically, when this research discusses a supply chain that is taking steps to become a value chain it implies that businesses are participating and communicating with intention to improve communication and reorient their model towards a skills-based model and not a goods based one. This is a
positive step but does not imply that a system of interconnected businesses has reached the end point of their growth once labeled a value chain.

### 2.2.4 Sustainable Supply Chain Management

A new discussion has emerged in the supply chain management literature and it surrounds issues of sustainability and resource depletion. The concept of the green supply chain and the sustainable supply chain encompass these discussions. These terms are occasionally used interchangeably but generally the green supply chain is a more specific term that is used to describe integrating environmentally conscious thinking into profitable supply chains (Srivastava, 2007). The description for sustainable supply chain typically refers to a more holistic approach to the supply chains, in terms of both the environmental impact of the supply chain as well as the social impact – sustainable supply chains often take a triple bottom line\(^2\) approach (Seuring & Müller, 2008).

Because the sustainable supply chain discussion is more inclusive it is that literature that is considered here.

Veteran researchers in sustainable supply chain management point out that research in this area has moved from a fringe topic, that many academics did not approach due to potential career stagnation, to a way to reframe supply

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\(^2\) An accounting framework that is a method of measuring a company’s social and environmental impact in addition to its economic value. Triple bottom-line accounting seeks to appraise not only (i) the conventional ‘bottom line’ of economic profit and loss but also (ii) a company’s ‘people account’, a measure of corporate social responsibility, and (iii) its ‘planet account’, a gauge of its environmental impact. The concept was introduced by John Elkington in 1994. (Law, 2014).
chain management research that should be integral and implicit in all supply chain management discussions (Pagell & Shevchenko, 2014). The use of the principles of the sustainable supply chain have been rarely applied to the issue of food waste. A 2017 study approached the issue by ascribing blame to the consumer for excess waste in the supply chain, indicating that consumers were too picky about product appearance and best-before-dates (Rohm et al.). Although preference for perfect produce as well as problems with understanding best-before-dates have been associated with waste (Parfitt et al., 2010) the complexity of the roots of these issues requires more intervention and thought than only consumer targeted blame.

Developing a deeper understanding of customer's willingness to use flawed produce and best-before-date confusion can help supply chain participants justify bringing imperfect produce to retail as well as assist government and industry policy makers in developing labeling protocols (de Hooge et al., 2017). Making changes based on knowledge in this area is rooted in issues of sustainable supply chain management, which seeks to produce optimal economic, environmental, and social outcomes (Morana, 2014).

2.3 Food Waste – Definition and Sources

The definition of food waste on its surface may appear to be relatively straightforward. Deeper consideration reveals complications. For example, are peels, bones and pits that cannot be consumed considered food waste? What about food products intended for human consumption but instead fed to animals?
Is food that was never harvested due to damage occurring in the field a form of food waste? There are many other issues that can complicate the definition of food waste. This means that a clear definition needs to be established in research to prevent confusion and miscommunication.

There are multiple definitions for food waste in use and in discussion in the academic literature. The FAO presented a description of food waste in 1981 as anything that was originally intended for human consumption but is instead discarded, lost, degraded or consumed by pests. This definition has been added on to include discussion of edible products intentionally fed to animals or by-products diverted away from the supply chain (Stuart, 2009) and also has been modified to include over-nutrition – the energy value consumed versus energy value required (Smil, 2004). Alternatively, the Organization for Economic Co-operation and Development (OECD) loosely defines food waste as crops left behind in fields due to poor harvesting or price fluctuations; edible produce degraded by disease; spillages, and spoilage during food processing, transport, and at the retail level; and uneaten food (2016). Despite the use of this definition the OECD concludes that there is a need for a harmonized definition, methodologies with units of measurement.

This dissertation echoes the sentiment for the need for a homogenized definition of food waste. For the purpose of this research the definition described by the FAO in 1981 will be used. Where food waste is described as "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, p. 3065). This definition, while being somewhat simplistic in language, provides clarity on most issues that come up as a result of the remaining research presented in this document and is also commonly implemented by other researchers. It does not, however, preclude discussion of some other interpretations in the context of the case studies.

Using this definition, we can discuss how waste is being produced in food supply and value chains. For individual businesses, such as farms, lacking infrastructure and technology leaves food liable to pests and environmental fluctuations which results in waste (Godfray et al., 2010; Parfitt et al., 2010). It is reasonable to assume this presents an issue for farms in developed nations, although to a lesser extent compared to developing nations. More data quantifying the levels of waste occurring due to sub-par technology or infrastructure would be useful to aid decision making around resource allocation.

Furthermore, there is likely a divide between waste in foods that are soft sided and easily damaged, such as tomatoes and strawberries, compared to sturdier products such as grain seeds and potatoes. It is likely that soft produce is wasted at a higher rate in both developed and developing nations, albeit to different extents, due to the difficulty associated with handling. This has not been well documented and requires further research. Additionally, labour shortages in developed and developing nations result in food left on the field (McKissick & Kane, 2011) which further contributes to the issue of food waste on the farm.

In animal product production waste occurs for reasons similar to produce production, such as storage failure and pest contamination. Sick animals, similar
to infected produce, require treatment and often this means the products cannot be put into the supply chain for a prescribed period of time. In Ontario, this period of time is prescribed by the Ontario Ministry of Food and Agriculture. It is possible that poor management practices impact the level of infection experienced on farm and therefore adjusting these management practices may reduce some of the waste that occurs on farm due to withdrawal times associated with treatment using medications. But more research is required to determine the impact of on farm management strategies.

Losses for distributor, aggregator, and processor businesses are thought to be less significant and often occur for similar reasons in animal products and produce (Gunders, 2012). Once again, products can be lost due to damage that occurs as a result of handling and pests. These issues can be minimized with improved technology and packaging that protects the food items. Despite the improvements possible, more vulnerable food products likely suffer higher losses due to damage, but this has not been well documented. Additionally, poor management practices that result in decreased speed of product movement could lead to food waste but more work on how the movement of products in the value chain impacts waste is needed. If buyers for products are not found quickly enough products may spoil and become waste. As well, specifications for shape, size, colour, or level of ripeness can result in waste (Willersinn, Mack, Mouron, Keiser, & Siegrist, 2015). It is possible that if the products do not meet the standards set by buyers the seller can move them to an alternative supply chain
or the products will be wasted. This has been confirmed anecdotally (Bloom, 2011) but additional research needs to be done to corroborate this.

At the retail end of the supply chain, food waste occurs for similar reasons to the other steps in the chain, including handling and storage failure. Poor management practices that result in inadequate inventory control, communication, and training can lead to food waste through damage to products such as squishing and bruising as well as spoiling associated with poor temperature control (Mena, Adenso-Diaz, & Yurt, 2011; Van Donselaar, van Woensel, Broekmeulen, & Fransoo, 2006). Furthermore, the North American concept that suggests full shelves are equated to higher sales may be associated with elevated levels of food waste. This idea seems to have been in place since before the new millennium but was quantified in 2001 when it was noted that inventory levels are related to the square root of sales (Dubelaar). This mentality is clearly depicted in the commonly expressed phrase; *stack ‘em high, watch ‘em fly*. This mantra encourages managers and store owners to keep their shelves as full as possible in order to maximize sales. Although, this is likely a contribution to waste it has not been documented or quantified and requires further research.

Much of the information available about where and how much waste is occurring in food supply chains is limited in scope and quantity. There are limited specialized product investigations, such as the investigation of potatoes as in the study done by Willersinn et al. (2015). From existing specialized data collections, literature reviews, and discussion pieces, inference is drawn to larger applications, but more data is needed to strengthen and deepen understanding.
of management tactics that impact waste. More work needs to be done to gather enough data to create accurate models that identify where, why, and how waste is occurring and in order to develop more effective management strategies to combat waste at each step of the supply chain. In the meantime, data collected from target geographical areas can be used to develop regional waste reduction strategies.

Currently, frameworks such as the Food Recovery Hierarchy used by the Environmental Protection Agency (EPA) in the United States provides a useful approach to waste reduction (Figure 2.1).

![Food Recovery Hierarchy](image)

Figure 2.1 Waste reduction strategy, as advocated by the Environmental Protection Agency in the United States.
The framework is described as actions organizations can take to reduce their food waste production and supports early action for waste reduction (EPA, 2017). This description can be interpreted as the EPA encouraging waste reduction early on in the supply chain while the definition here focuses on the bottom section of this period, specifically concerned with food that ends up in composting, landfill or is incinerated.

The Food Waste Recovery Hierarchy is a practical framework to reduce food waste generation, but its impact is not well documented. Research from 2009 noted that food waste in the US, described as a function of food supply compared to food consumed, has increased steadily between 1974 and 2009 (Hall, et al.). Additional work is needed to evaluate the specific impact of the waste recovery hierarchy but despite this it can be used as one tool to help focus attention on food waste generation.

Perfect Food

An interesting anecdotal story is included in American Wasteland and it describes the abundance of crops left on the fields after harvest due to imperfection (Bloom, 2011). The presence of this issue is supported by the success of the baby carrot. A farmer developed a new product, the baby carrot, in response to up to 70% of his harvest remaining on field due to failure to meet appearance standards (Weise, 2004). It is likely that this is not an isolated incident. If many products lack innovative waste solutions it means ugly products are likely being left unused on fields. Unfortunately, there is limited controlled
data collections available to document this meaning more data is needed in order to have a productive discussion around solutions.

Despite the presence of success stories that describe some foodstuffs avoiding waste due to innovative product development or diversion to alternative supply streams, there are still significant levels of food waste occurring at many steps in the supply chain due to appearance standards (Predieri, Ragazzini, & Rondelli, 2006). This waste is associated with the larger issue of food appearance standards. Overall, it is estimated that in developed nations, 40% of edible food is wasted due to imperfection (Stuart, 2009). But this seems to vary by product with some farmers losing up to 70% of their vegetable crop due to irregular shapes, sizes or colouring (Gunders, 2012; Weise, 2004). Some alternative streams exist for irregular products such as processing irregular apples for canning or juicing. The extent of available tactics for waste diversion is unknown. Farmers also can take their produce to alternative food networks that may be less demanding on food appearance, such as farmer’s markets (Renting, Marsden, & Banks, 2003), but this requires expending additional effort for sorting, transport, and sales. Despite the presence of diversion techniques and processing methods to improve the visual suitability of products, there is a general understanding that a substantial amount of produce is wasted in field and post-harvest because of imperfection. This topic requires more investigation to determine how much waste is occurring, why, and what alternative streams are available for the waste products.
Waste due to imperfect food is commonly associated with produce but animal products such as meat, eggs, and cheese have specific appearance related issues that cause waste. For example, most consumers prefer a bright red hue in their beef cuts and although, when given a blind taste tests consumer could not differentiate flavour, appearance still impacted purchasing decisions (Carpenter, Cornforth, & Whittier, 2001). Because steaks are often considered less desirable when they are deeper in colour, meat processors and retailers expend significant resources and discard products to ensure a final product with bright red hue is presented to decrease consumer refusal rates (Bekhit et al., 2003; Raharjo et al., 1994; Ripoll, Panea, & Albertí, 2012). This issue can be related to a relatively uneducated consumer and is likely to result in more food waste throughout the supply chain. Perfection associated waste likely occurs at multiple steps but at the grocery store level in particular, due to meat becoming darker with age and it being less-aged at locations in the supply chain closer to the slaughter. Grunert (2005) points out that although, when asked, consumers may indicate that things such as breed, age of the animal, and slaughter date are more responsible for the meat quality, they are unable to figure out how to properly use this information and thus fall back on relying on meat colour and fat pattern when purchasing, despite these qualities not being reliable methods to predict taste. This points to a distinct need for improved stakeholder communication and education to reduce unnecessary waste of darker meats.

Communication
A 2011 study evaluated the root causes of food waste along the supplier-retailer interface in Spain and the UK and determined that although there were several causes of waste, the most controllable issues were related to management practices and particularly poor communication strategies within the organization and across the supply chain (Mena et al., 2011). The idea that improving communication may help eliminate waste is not new (Associates, 1993) but the discussion of food waste elimination through communication for environmental, social and ethical reasons is one that has emerged more recently. Inter-firm cooperation in food supply chains revealed that greater efficiencies can be achieved, in part through food waste reduction (Stank, Crum, & Arango, 1999). These are early findings and more contemporary research into supply chain coordination and cooperation has revealed the value associated with better coordination and communication (Cao & Zhang, 2011; Gabler, Agnihotri, & Moberg, 2014; Marqui, de Moura, & Alcântara, 2013). Despite this there is a distinct deficiency in the literature on a discussion of supply chain coordination and communication as it relates specifically to food waste. This ties directly to the discussion of service dominant logic and the concept of the offering in Section 2.2 and the bullwhip effect which encourages increased communication as a means to produce a more value laden offering and reduce the impact of the bullwhip effect.

**Bulk and Sale Purchase**

The discussion of bulk and sale buying is a subset of the discussion around supply chain communication and food waste. Bulk deals encourage
consumers to purchase larger quantities of products while sale items may encourage purchase when not needed. When the occurrence of a bulk deal promotion is not properly communicated with the rest of the supply chain it may result in stock piling, as described by a management theory called the bullwhip effect as described in Section 2.2. This has been corroborated in work that reports consumers indicate being “tempted by multipacks” or “tempted by price reductions” resulting in them producing more food waste (Cox & Downing, 2007). Interestingly, one study found that consumers reported they effectively manage deal purchases and these consumers tended to be in households that produce lower waste overall (Parizeau, von Massow, & Martin, 2015). In general, better communication across the supply chain would likely help reduce food waste for food supply chain members but thoughtful and informed communication across the food supply chain that discourages bulk deals in order to reduce waste at all levels requires further investigation.

2.4 Synthesis, Purpose, and Propositions

The management concepts discussed in this section will be used as scaffolding to build the research presented in the remainder of this document. Food waste data taken from many sources specifically relevant to the case studies considered in Chapters 4, 5, 6, and 7 as well as using data from academic, government, and industry publications will be used for extrapolation of information where necessary. This data is used to develop an understanding of
the issues and will be placed on the management literature framework to build models and hypotheses to address the issues noted.

Data presented in this literature is used to formulate a purpose statement, as described by Yin (2014, loc. 1276), to inform exploratory food supply chain research.

**Research Purpose:** To understand where food waste is occurring in three food supply chains, as well as why and how food is wasted in food supply chains for the purpose of creating frameworks to increase understanding and hypotheses to direct future research.

The success of this research will be judge based on identifying novel information that can contribute to the development of strategies for waste reduction.

Furthermore, the data from the literature review is used to build four propositions that will helped direct the remaining research. These propositions are addressed in the presentation of concluding hypotheses in Section 7.9, intended to spur further research based on the findings presented in this document. The research propositions are;

1. Product shelf life and vulnerability to handling impacts waste produced in all levels of the food supply chain, but particularly in retail.

2. The presence of the bullwhip effect in a food supply chain is associated with food waste generation at all levels of the food supply chain.

3. Effective communication in food supply chains will facilitate food waste reduction at all levels of the food supply chain but particularly in processing and distribution.
4. Moving from a supply chain to a value chain, that encompasses the concept of the offering, will decrease food waste at all levels of the food supply chain.

2.5 Conceptual Framework

To identify areas and management strategies that can offer an opportunity for food waste reduction there needs to be an understanding of where waste is currently occurring in food supply chains and why. In order to have discussions around waste production in any supply chain a visual framework that presents the structure and interactions of the food supply chain is necessary. For the purpose of this research Figure 2.2 will provide this basic understanding.

Figure 2.2 Movement of supplies and information in a generic food supply chain
It is important to note that this diagram depicts a generic supply chain. Supply chains are often highly complex and highly product specific. They can shift connections and product movement on a regular basis making a depiction that accurately represent the nuances of all supply chains impossible.

Figure 2.2 shows the major elements that will be key to move forward in discussions about this research as well as to build off of to facilitate further research. It describes where information and products flow between the different major supply chain participants. It is expected that the information and product flows can be altered or improved but this diagram provides a general understanding that acts as a starting point for discussion. The diagram also shows the main types of businesses that participate in the food supply chains. For each type of food product there will be numerous unique connections but the diagram here is intended to present the most common types of businesses that interact.

This diagram can be used to discuss where, how, and why waste occurs. When looking at the whole supply chain there are likely reasons for food waste attributable to practices at individual, isolated steps in the supply chain as well as reasons for food waste attributable to whole supply chain practices and strategies. In this figure, we can visualize each step and begin to understand that there may be issues that occur within any single step of the supply chain (e.g. issues that only impact farmers or issues that only impact processing facilities) as
well as issues that have supply chain wide implications (issues such as appearance standards that impact waste at every level).

This diagram is also used to describe where the application of different management theory may provide a useful contribution to the flow or products and information for the purposes of waste reduction. Specifically, service dominant logic, using the concept of the offering is suggested to strengthen the flow of information represented by the dashed, black lines. This framework should also be viewed through a lens of stakeholder theory that encourages the consideration of the value each stakeholder has on the interactions of the system. Finally, by applying these concepts it is suggested that the supply chain depicted can begin moving to a true value chain, that encompasses the tenants outlined in Section 2.2.3.

2.6 Supply Chain Communication

The flow of information in Figure 2.2 is an important consideration. The hashed lines in the figure depict where information is likely to be flowing between supply chain participants. Developing an understanding of this for any given, unique supply chain will be important to understand how waste is generated, particularly waste related to systemic supply chain practices and to issues of communication that relate to the bullwhip effect. Also, understanding how communication and information flows, or does not flow, and how the movement of information can be improved presents a worthwhile consideration and is particularly relevant in discussing the ability of any given supply chain to move
towards functioning according to the description of a value chain presented in this document.

Figure 2.2 shows how supply chains interconnect and provides a depiction of how the application of various theories may impact the operations of the chain. Applying the concept of the offering, from service dominant logic, can be used to increase the value the final product and move a business interaction to become more skills and value laden, which are seen here as hallmarks of a value chain. This may be also accomplished through improved flows of information at all levels, including to the end consumer.

The impact of communication as described by the bullwhip effect entails products being wasted at an increased level down the chain as a result of poor flows of information (Lee, Padmanabhan, & Whang, 1997). It is possible that the bullwhip effect has additional implications for food supply chains because of the highly degradable nature of food products. This effect is presented in Figure 2.3.
The bullwhip effect, shown in blue, describes how errors in ordering can be perpetually increased as you move up a supply chain, if communication is not properly managed between supply chain participants. The bullwhip echo, a new concept introduced in this dissertation, suggests that in response to the bullwhip effect, an echo will form in which food waste will increase in the direction opposite to the bullwhip. Using this model, in combination with qualitative interview data collected from supply chain participants and industry published quantitative data we can identifying the waste generating potential of a food supply chain and how communication impacts it.
By considering the impact communication can have on supply chain function in general, and food waste in particular, we may be able to improve supply chain efficiency to reduce food waste. Furthermore, if the concepts introduced by sustainable supply chain management are included in this discussion these conceptual models can be used as a basis to develop a better, more sustainable offering through waste reduction, by improving communication and therefore product flows throughout the chain, moving towards the creation of a value chain.

2.7 Stakeholder Theory

A final important element is a discussion of stakeholder theory. Stakeholder theory is a management theory that while not very prescriptive, will provide a basic tool to create understanding from which the research for this dissertation will pivot from. In fact, acting as a framework to build from was the intent of the theory, as described by its developer (Freeman, Harrison, Wicks, Parmar, & De Colle, 2010). Stakeholder thinking can force a refocusing that brings alternative parties into perspective to create a more holistic solution for any issue. Stakeholder theory takes a practical view of the impact that organizational activities have on all parties, or stakeholders. It also requires an evaluation of the specific circumstances of a particular issue to properly identify stakeholders. This theory describes creating value for all parties through a process of value co-creation (Freeman, 2004). It builds on Drucker’s recognition
that there can be positive, non-economic consequences as a result of managerial decisions (Wren and Bedeian, 2009, p. 497).

This theory is very useful for application in research that seeks to improve inequality or waste issues because of the impetus to consider diverse and fringe parties. Freeman et al. describe stakeholders as those who gain value from a business. They are those that are touched by organizational activity and affected either positively or negatively (Freeman et al., 2010, pp. 10-12). It is this description that gives the theory far reaching flexibility and application. It allows discussion that is beyond pure economics and encourages discourse on how a company's activities can cause problems, such as excessive waste, and then helps identify the impact that problem may have. Furthermore, in order to be properly implemented, a plan that determines each stakeholder group at any given location must be developed. Developing a clear strategy will prevent the use of broad policies that are hard to implement. Stakeholder theory has been widely applied to the development of green products (De Boer, 2003; Jay Polonsky & Ottman, 1998) and for the improvement of environmental sustainability of manufactured products (Dangelico & Pujari, 2010; Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010; Vanegas, 2003). A key to the application of this theory is that it maintains economic and ethical perspectives and that these entities should not be listed as separate perspectives but as overlapping propositions or goals (Wren & Bedeian, 2009, p. 497).

Because of the sweeping implications of food waste, stakeholder theory is a useful tool to discuss potential solutions and their tangible impacts on close-up
and distant networks. Interestingly, this theory has not been directly and holistically applied to the issue of food waste. Stakeholders in general are often mentioned in research that examines food and sustainability issues (De Boer, 2003; Sarkis et al., 2010) but little research appear to discuss the issue based on a mindful consideration of each stakeholder group in any given situation. This may be due to the complex nature of considering each stakeholder group. It may be more straightforward to refer to the existence of other stakeholders and avoid detailed discussions of the interactions between the groups. This research seeks to evaluate the key players in specific supply chains and then evaluate the broad impact, in terms of waste generation, on external stakeholders – consumers. The impact will be evaluated in terms of the negative implications food waste can have socially, environmentally, and on the food system in general.

Studying the problems associated with food waste and sustainability are difficult to do in entirety but through the application of stakeholder theory you can begin to develop an understanding of multiple participants in the picture to create a more complete understanding of the issues. For this research many stakeholder perspectives were included to create a picture of the whole supply chain. Despite the desire to connect with all stakeholders impacted by a supply chain’s activities this was not always feasible or possible. Instead information from many stakeholders was used as well as data from external sources to create a snapshot of specific supply chains. This research can be combined with other work to create a picture that includes other stakeholders such as consumers. In order to suggest better ways of reducing food supply chain waste,
stakeholder theory should be incorporated into resultant hypotheses for consideration in further research.

2.8 Conclusion

Using the conceptual framework presented in Figure 2.2, stakeholder theory, service dominant logic, the bullwhip effect, and sustainable supply chain management can be applied to the food waste problem for a more thorough discussion on the implications of waste and where interventions should be applied to best combat it. The diagrams presented in Figure 2.2 has the potential to improve communication and provide a visual depiction of the research content. Stakeholder theory provides a useful language to frame the discussion of food waste reductions and how to move from a supply chain system to one that embodies the attributes of a value chain.

This dissertation seeks to bring together many different facets of academic literature in order to address a serious issue. It is unique because of the variety of topics covered and integrated. It describes the necessity for a deep understanding of these topics as well as the impulse for an engaged scholarship approach that includes many different perspectives.

Despite the challenge associated with this there is meaningful possibility when applying this method of research. As described by Van de Ven in his guide to organizational and social research, there is a need for engaged scholarship. Engaged scholarship in this context posits that engaging in the perspectives of diverse scholars and stakeholders can bring understanding to a complex problem
or phenomena (Van de Ven, 2010). This approach to complex problem solving requires acquiring perspectives and information from many key areas to develop the most appropriate solution. While focused and very specific research is likely to be useful and instructive to only a small few, engaged scholarship is typically more accessible and more rapidly useful. This type of work seeks to employ the strategy of creating research that moves the conversation forward to derive the maximal benefit for all concerned parties.

Although the discussion around the problem of food waste is ballooning, investigations into clear strategies to reduce levels in food supply chains are limited. Work is needed on many fronts to help address this problem. Waste is known to occur at many different points as food travels from producer to consumer. This dissertation provides a framework to understand and address waste within food supply chains. Implementing this framework will help researchers and practitioners to move from their silos of understanding to become more dynamically engaged. This type of activity will assist in speeding the development of a solution to the food waste issue and the larger problem of low food sustainability worldwide.
Chapter 3 – Methodology

3.1 Introduction

In order to understand the material contained in this proposal a discussion of the philosophical underpinnings and perspectives of the research are necessary. Pragmatism is a foundational understanding in this discussion. The roots of pragmatism stretch back to the late 19th century and it has been debated and evolved since then. It has enjoyed a resurgence with social scientists and mixed-method researchers due to its versatility and practicality (Morgan, 2014). Despite this, it should be highlighted that pragmatism is more than a convenient philosophy to base multi-dimensional research on. Pragmatism encompasses other common philosophies, namely post-positivisms which claims that the world exists independent of our understanding, and constructivism which accept that the world is created by our conception of it.

The work of the pragmatist John Dewey brings together the ideas of post-positivism and constructivism by describing that experience is conflated with both the uncertain, which is based on our socially constructed perceptions, and the predicable, based on stable facts and laws (Dewey, 2008). Morgan describes these views as “two sides of the same coin” for pragmatists like Dewey (2014) and so researchers should be aware that any attempt to produce knowledge occurs within a social context. Morgan takes this discussion further and explains that pragmatism removes the need for relying on a metaphysical discussion of ontology and epistemology by treating the differences that inform these
classifications as social contexts for inquiry, rather than abstract philosophical systems (2014).

This research seeks to use abductive reasoning to derive socially constructed theory based on collected data. This research also ascribes to many of the tenants of Freeman et al.’s (2010) stakeholder theory. Consideration of the effect stakeholder relationships have on food waste generation is at the core of this dissertation, that underlays most discussions and analysis in the case study chapters.

Stakeholder theory is implicitly pragmatism grounded and this research is logically taken from a pragmatic perspective. The pragmatism understanding of William James that describes pragmatism as a method to solve metaphysical disputes by comparing practical consequences and allowing that truth is relative and can change over time (Van de Ven, 2007, p. 56) is considered to be instructive for this research.

It is important to note, that although this research is positioned with a pragmatism base, various activities are not to be deemed as right or wrong when addressing the issue of food waste. The pragmatic approach to research allows postulation but demands that theories be objectively tested, and only then can they be accepted or dismissed on subjective terms.

Abductive reasoning, the process of making inference to the best possible explanation (Harman, 1965), is a consequence of this moral stance, and leads to a creation of a hypothesis to test. The goal of this research is to produce information for the creation of testable hypotheses. In order to conduct abductive
research observations are made and tested to produce a theory. The pragmatism based philosophical bias dictates allowing data to drive acceptance or dismissal of the ideas. Understanding this allows a clearer view of the issue and will lead to more effective discussion of the research contained here.

### 3.2 Research Model

In Yano and Sakai’s work they outline four challenges for promoting waste prevention at all levels and the importance of reduction above all (2015). This work suggests that it is necessary to accomplish this through (1) making the definition of waste types clearer; (2) developing a standardized, consistent monitoring method; (3) clarifying the causal linkage between prevention effects and stakeholders’ behaviour, and (4) quantifying the environmental effects of waste prevention. For points 1 and 2, as already discussed in sections 2.3, a clear definition and tracking methods for food waste are clear needs and this research will attempt to add to this discussion. Furthermore point 3 will be investigated, working to build a clearer understanding for the reasons behind the waste occurring at all levels of supply chains before food reaches the consumer. It is expected that research that addresses point 4 can occur through the testing of the hypotheses generated at the conclusion of this dissertation.

This research was carried out to evaluate where, how, and why food waste is occurring. The contextual reasons food waste occurs in different food supply chains is valuable information whose collection is made possible through taking a case study approach. The case study method is employed in order to
develop causal linkages and an in-depth understanding of the extent and the nature of the issue of food waste within each step of specific food supply chains. The research uses multiple methods including semi-structured interviews, observation, collection, and analysis of any supporting documents interview subjects provided. Also, additional data is collected from external reputable sources, such as industry and government produced data and peer reviewed academic publications, to deepen understanding of the information collected.

The interview process is described in detail in the Appendix section of this dissertation (Appendix 2). The sampling strategy employed is according to Teddlie and Yu’s description of purposive sampling (2007). Organizations and individuals where identified and contacted based on their expected usefulness to contribute to the understanding of the specific supply chains under investigation. Snowball sampling was then used to expand the selection of interview subjects, with initial interviewees indicating other useful contacts and facilitating introductions. Observation were made, as allowed by the interview subjects and information collected from observation was used to further refine interview questions and identify additional locations for investigation and interview subjects. The interviewee was asked if they had any documents they felt comfortable providing the interviewer with that describe policies or procedures around dealing with or preventing waste as well as how they communicate with other supply chain participants. This request was posed when first contact was made to ensure the interviewee had ample opportunity to reflect on the request
and compile any documents they deem as appropriate prior to the in-person-interview.

This research is conducted in line with Yin’s suggestion that case studies are best suited to answer how and why questions, as well as when contextual conditions are believed to be relevant to the phenomenon and context, and finally when the boundaries between the phenomenon and context are not clear (Yin, 2014). For this research, the overarching question asks how and why edible food is wasted throughout the supply chain and how we can make changes to minimize this waste. Inherent in this discussion is understanding where food waste is occurring in the food supply chain under consideration. The interview guides (Appendix 2) outline the basic questions asked of participants and shows a search to answer how and why questions. It is noteworthy that instead of being entirely specific how and why questions, the interview guide contains questions that are worded to be cumulative and produce the answers to the larger how and why questions listed above. Furthermore, some who, what and when questions are needed to provide context, and lead to answers to the how and why questions at the heart of the interview. This is in line with the nature of an exploratory case study (Yin, 2014).

Additionally, it is believed that the context, the social and physical structure of specific food supply chains, are relevant to the levels of food waste produced. Furthermore, the boundaries between food waste production in supply chains cannot be clearly separated from the context of the specific supply chain.
Meeting these criteria, according to Yin makes this research a good candidate for the case study model (Yin, 2014).

Based on this the primary purpose of this research is to address the following objective:

**To understand where food waste is occurring in three food supply chains, as well as why and how food is wasted in food supply chains for the purpose of creating frameworks to increase understanding and hypotheses to direct future research.**

The specific case studies described here seek to address the research question:

**Where and why does food waste occur in dairy, leafy green, and apple food supply chains in Ontario, Canada, and how do supply chain factors impact the production of food waste?**

The research question is posed using Yin’s suggestions that boundaries be placed on the case to prevent too broad a question from being addressed (2014). This is particularly relevant for exploratory case study research (Yin, 2014). Furthermore, the concept of limiting a research question based on time and place was posed by Creswell (2017) and is employed here.

### 3.3 Unit of Analysis

The unit of analysis in any case study is the “case” being considered (Yin, 2014). In this investigation, there will be three case studies, one for each food product under consideration (Table 3.1), as well as one synthesis case that considers all three food products together. Each product will be followed through
the supply chain from farmer to retailer. At each point in the supply chain multiple interviews were carried out to increase internal validity of findings (Figure 3.1). Because the interviews were semi-structured there was potential within each case study for branching off points to delve into additional areas of interest such as waste that occurs as a result of organic food production and waste that is associated with different processing techniques. For example, an apple producer who produces both organic and conventional apples may see more wastage from their organic products due to increased numbers of blemishes because of pests. Although the core questions of the interview remained consistent around waste levels, communication levels and styles, and food costs in the conventional supply chain, when an interviewee provided the opportunity for a discussion around waste from alternative supply chains, it was pursued to gain as much insight as possible.

This flexibility provided a subset of data that can deliver an interesting comparison to the conventional supply chain and to deepen internal and external validity of the research (Yin, 2014). Despite the ability to deviate from the questions outlined in Appendix 2, the focus of this investigation was on consumer goods that contain more than 50% of the product under consideration. During interviews, the task of keeping interview subjects focused on the food item of interest did not pose a substantial issue.

The products chosen for investigation are listed in Table 3.1 and they are described in terms of vulnerability. Vulnerability is used to note the potential for damage due to transport and handling. Detailed descriptions of each product are
provided in the proceeding section. Figure 3.1 shows a simplistic depiction of what areas in the supply chain were investigated for each product. Multiple interviews were pursued at each step in the supply chain for each product under consideration. Because each food supply chain is highly complex and convoluted this structure required deviation and adjustment on an ad-hoc basis, based on the information collected throughout the interview process. This was necessary because no resources that describe the exact structure of each supply chain are available to build an investigation protocol around. Plans for interviews needed to build off information obtained from other interviews. In fact, the structure of these food supply chains are highly product specific, therefore, this figure provides a simplified overview of a generic food supply chain.

Table 3. 1 Food products studied

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<tr>
<th>Category</th>
<th>Vulnerability</th>
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<td>Fruit</td>
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<td>Vegetable*</td>
<td>Leafy Greens</td>
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<td>Animal</td>
<td>Bovine Dairy</td>
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*Produce that is treated like a vegetable by consumers (Edwards & Hartwell, 2002).

Farmer ---------> Distributor ---------> Processor ---------> Retailer

Figure 3. 1 Stages of the supply chain where interviews were conducted
3.4 Products to be Studied

The food items to be studied are selected based on several criteria.

1. The item must to be produced in Ontario. This is important because the scope of the study needed to be an approachable challenge. Furthermore, in order to develop a depth of understanding the scope needed to be limited to facilitate collection of detailed data about each food item.

2. Food items that are widely consumed were chosen to roughly evaluate products that may be significantly contributing to food waste.

3. There must be a deficit of information on the levels of waste in the food supply chain for that product.

Food items were selected as whole, raw products. In order to keep the scope of this project feasible the most common food products that contain over 50% of either apples, leafy greens, or bovine dairy were considered. For example, apples were investigated in this study and were chosen based on the potential level of waste that occurs with the fresh whole apple, apple juice/cider, and apple sauce. For leafy greens, raw and frozen are considered. For bovine dairy, fluid milk including creams, as well as cheese, ice cream, yogurt, and butter are considered. These products were chosen by taking an informal survey of the most prevalent products under each category on the shelves of 10 Ontario grocery retail shelves (Appendix 5).
3.4.1 Case Study One – Dairy Supply Chain in Ontario

The bovine dairy industry in Ontario is a very large economic force in the province and the Dairy Farmers of Ontario estimate that dairy farmers contributed $8.1 billion to the Canadian GDP in 2013 (DFO, 2014). This indicates a large dairy farmer presence in Ontario which is in line with criteria one that stipulates the need to have the food product produced in Ontario. For criteria two, the Food and Agriculture Organization (FAO) of the United Nations lists milk produced from cows as the most largely consumed animal product worldwide (FAO, 2013) making investigation into waste products from this process very important. Finally, for criteria three, once again there is deficit in data that describes the waste of this product. Interestingly some news articles have been published describing wasted milk in the Ontario supply chain (Mckenna, 2015). This evidence makes the product more interesting and useful to investigate. In addition, the unique aspects of Canada’s supply management system for bovine milk production and distribution provides interesting and rare learning opportunities that may contribute to the development of more effective strategies for waste reduction. Similar to the other products, there are large quantities of products made from milk. For this investigation, several Ontario grocery stores were surveyed, and the top bovine dairy products were selected. These products include fluid milks including creams as well as cheeses, ice cream, yogurt, and butter.
3.4.2 Case Study Two – Leafy Green Supply Chain in Ontario

Leafy greens represent an opposition to apples in the food supply chain because of the relatively short shelf-life as well as a high level of vulnerability to damage. For the first criteria for product inclusion, there is a thriving leafy greens production network in Ontario and production strategies range from greenhouse, hothouse, hydroponic, to traditional outdoor growers (Vyhnak, 2013). Furthermore, consumption of leafy green products in general seems to be increasing with lettuce production 1.5 times higher in 2016 then in 2002 (Statistics Canada, 2017a). Evidence on levels wasted in the food supply chain for leafy greens is lacking but anecdotal retail data indicates that leafy greens are frequently marked down for quick sale due to short shelf-lives indicating the likely presence of a waste issue at the retail level. Furthermore, their short shelf-life, relative to other products (Subramaniam & Wareing, 2016) indicates waste generation in other parts of the supply chain may be an issue.

3.4.3 Case Study Three – Apple Supply Chain in Ontario

The supply chain for Ontario grown apples is evaluated for multiple reasons. In line with criteria one, Ontario is a large apple producer making investigation of these products very relevant. Furthermore, in line with criteria two, apples are highly consumed making rank number 18 on the FAO’s 2012 list of the most valuable crops produced (FAO, 2013). Also, the shelf-life of apples is relatively long. This is in direct opposition to the other products under consideration. As well, and most importantly, there is evidence that imperfect
apples are directed into three supply streams with the potential for those unsatisfactory foods to be wasted (Leemans, Magein, & Destain, 2002). Finally, evidence indicates that when apples are not sorted carefully by the appropriate sizing, spoilage increases (Lorestani, Omid, Bagheri-Shooraki, Borghei, & Tabatabaee, 2006) which could lead to increased pressure to dispose of unappealing sized or shaped fruits. According to the Ontario Apple Growers there are ten primary varieties grown in Ontario. Because this investigation sought to follow both raw and processed apples it focused on the Honeycrisp, as a good example of an apple primarily sold as a table apple, as well as the McIntosh, as a good example of a juice or sauce apple (Growers, 2014), but did not limit discussions of interview subjects to increase data quantity and quality.

In line with criteria three, there is a lack of information relating to the structure and levels of waste of apples in this food supply chain. This exploratory investigation aimed to create a starting point to understand the potential sources of waste in the apple supply chain and encourage additional investigations into other apple varieties.

3.4 Technique and Analysis

Multiple individuals at each step along the identified supply chain pathways (Figure 3.1) were interviewed using a semi-structured format to allow direction in the interview without inhibiting interviewees from expanding on topics of interest to them. The information collected was used to apply to the research purpose and question. Data from interviews, direct observation, and industry,
government, academic, and popular non-fiction documents were analyzed to achieve data triangulation.

A total of 27 interviews were planned but in reality, 56 interviews were conducted as a result of snowball sampling (Table 3.2). The subjects interviewed were from all aspects of the three supply chains considered and many subjects performed multiple roles. For example, one large apple grower also processed apples to make various types of sauces and dessert. When this happened the interview subject's data was used to inform discussion about farming and processing.

Interview duration was based on the number of products being discussed, the time available of the participant, the participant’s willingness to discuss the subject in depth, and the ability of the subject to succinctly explain their thoughts. Interview lengths ranged from 20 minutes to over 2 hours.

The research developed based on using existing information about supply chain food waste available in industry, government, academic, and popular non-fiction literature to create a basis to develop a conceptual framework (Figure 2.2) and a semi-structured interview question model. A model for the interview questions for each case study is outlined in Appendix 2. At the time of conducting interviews, direct observational data was taken in the form of a pre and post interview site visit, when possible. During each visit general observations were made about the size of the operation, apparent level of organization and cleanliness, types of products produced or handled, and any other elements that stood out. It should be noted that site visits were not possible for three interview
subjects due to the interviews being conducted by phone and the bio-security features of the operation.

Once the interviews were completed each interview was transcribed. In order to speed the process of transcribing voice-to-text software, called Dragon as well as TranscribeMe, were used. Interviews were then listened to again, after a rough transcript was produced by the software, in order to clean-up the quality of the text produced and to highlight and make note of emergent themes. This technique allowed for minimal time to be spent on the transcribing portions of the interviews that strayed away from the topic of interest, while still having a representation of that content in rough form within the text. Furthermore, after initial transcribing, listening to interviews multiple times at accelerated speed allowed deep familiarity with the interview and ability to clean the transcription, without excessive time expenditure. This technique allowed for drawing out additional insight and findings after initial encoding and during the writing process. On average transcription length for an interview was 10 pages of single-spaced text and approximately 5500 words. Because 56 interviews were completed it resulted in approximately 560 pages of single-spaced text.

The method of analysis used for the data was based on the work of Yin and was modeled around the concept of working the data from the “ground up” (2014). The early process of data analysis involved writing memos starting during the data collection phase and continuing into the data transcription and analysis phase. These notes were physically arranged and manipulated to identify themes and commonalities (Yin, 2014, loc. 3489). During the data analysis phase themes
of interest were tabulated for their frequency and mapped on the supply chain diagram (Figure 3.1) (Yin, 2014, loc. 3478). These strategies applied to the analytical techniques of pattern matching and explanation building for the generation of hypotheses, as well cross case synthesis (Yin, 2014, loc.3645-4140). For pattern matching, findings were compared to the conceptual framework shown in Figure 2.2 and then using an iterative process these were compared against additional evidence from the literature, government documents, and news publications (Baškarada, 2014).

Additionally, the emergent themes were evaluated using a single case analysis that looked for patterns and insights within each food product investigated. Following this a comparison across case studies was performed to identify patterns noted in multiple food products. This was done by modeling the themes from each case study on the supply chain conceptual framework (Figure 2.2) and noting similarities in themes, as well as returning to the transcription data to identify additional information.
Table 3. 2 Interviews Conducted for Each Case Study Product

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3.5 Methodology Assessment

Controlling construct, internal, and external validity, and reliability were factors of interest monitored throughout the case study process. Construct validity was controlled by clearly defining food waste (Section 2.3) and by identifying operational measures of communication and product flows from supply chain and government literature (Chapters 4, 5, 6, and 7) to discuss waste activity in the supply chains. Yin encourages using multiple sources of evidence, establishing a chain of evidence and having a draft report viewed by key informants (2014). In this research data from interviews, direct observation, and industry, government, academic, and popular non-fiction documents were analyzed. Also, interview participants were provided with the findings of the case studies as well which quotes were used from them in order to give them an opportunity to respond and suggest edits. All feedback collected from study participants was considered and changes were made to reflect the responses.

Internal validity is a concern when inference is made without direct observation (Yin, 2014). Because the case studies presented in this dissertation are largely exploratory in nature this is not an issue of major concern. Despite this, because inferences are made based on data collected without direct observation, systems of controlling internal validity are put in place including pattern matching to the predicted conceptual model produced in Figure 2.2 and Figure 2.3. Because no quantitative data was collected from case study participants statistical means cannot be used to test the relationship between the predicted model and information gathered. Instead, inference can be drawn
based on interview content and document analysis. Because this is an exploratory case study the goal is to produce data for hypothesis generation to spur further study (Yin, 2014, loc.3645-4140). Finally, Chapter 7 presents a multi-case study comparison and discussion that works as a check on internal validity by strengthening the findings of each case study through comparison (Yin, 2014, loc.3645-4140).

External validity is considered. It is the ability to make generalizations and is first controlled by ensuring that “how” and “why” questions are being asked in the research. Furthermore, as described by Yin (2014), using theories and presenting rival theories to explain findings helps contribute towards the external validity of the case. But, because of the exploratory nature of these case studies findings creating generalizable results is beyond the scope of this work. Instead, the findings and discussion sections indicate areas where future research may lead to quantitative data and generalizable results.

Reliability provides the ability for anyone to replicate the study if desired. This was accomplished by providing clear documentation of the work done to collect the data. A clear protocol, as described in Section 3.4, was followed to ensure transparency in data collection and results analysis.

3.6 Limitations

The data collection process was complicated by the sensitive nature of the subject. There are negative connotations associated with food waste and it is expected that no business wants to be associated with waste. It is likely that this made potential research subjects nervous to be interviewed and, on several
occasions, caused them to cancel appointments to be interviewed. Furthermore, two research participants asked for their data to be removed after the study was complete. This late stage removal of data complicated the analysis as one subject in particular had provided very useful information and asked for it to be removed after a full and thorough write up had already been completed with several of their quotes and information used as strong supporting material. Their decision to withdraw from the research represented a loss of a significant amount of work, analysis, and content.

The sensitive nature of the food waste discussion also likely made the collection of quantitative waste data impossible within the confines of this study. All research participants were asked to provide data on waste and communication procedures, if they felt comfortable doing so. No quantitative information was obtained.

Furthermore, it was noted that research participants were often observed to be guarded in their conversations when specifically asked about waste. This made it difficult to obtain valuable information requiring extensive review of supplementary material obtained from other sources to corroborate themes noted. Additionally, several potential research participants that expressed interest in discussing their operation and waste management pulled out of the study after receiving the study information and confidentiality forms. Many others did not respond to interview requests which included a brief description of the project specifying that it was looking at food waste.
Additionally, the difficulty associated with finding interested and cooperative supply chain members limited the quality of the data obtained. While sufficient supply chain participants were interviewed to create an understanding of each supply chain, the willingness of subjects to provide quantitative data related to their business slowed and limited data analysis and impact of the results. This research was initially designed with a quantitative data collection element in mind, but no research participants were willing to offer access to their food waste quantitative data. This meant the interview contents could only be corroborated by data from other research, government, or industry groups.

Finally, distrust between supply chain members provided a unique barrier to data collection. Most research participants expressed concern that they wanted to see the information collected about other supply chain members while also being worried about what information other supply chain members would see from them. It is difficult to know how this impacted the content of the interview data collected but it seemed, in the very least, to place limitations on the information interview subjects were willing to share.
Chapter 4 – Case Study of Bovine Dairy Supply Chain: Food Waste – Where, How, and Why

4.1 Introduction

This case study undertakes a preliminary investigation of waste in the Canadian dairy industry in general and the Ontario dairy industry specifically. It scrutinizes the Ontario dairy supply chain in detail using one-on-one interviews with supply chain participants at all levels as well as extensive examination of supplementary industry documents. A total of twenty-two interviews were conducted with ten dairy farmers, six dairy processors, three dairy marketers, two dairy truck drivers, and eleven retailers of dairy products. Interviewees represent large and small organizations as well as conventional and organic production and handling strategies. The case is written to look at where waste is occurring at each step in the supply chain, identify causes of waste, and to suggest opportunities to reduce or eliminate waste and improve efficiency. The research was designed to be iterative and incremental to develop common themes expressed by supply chain participants that relate to waste generation and efficiency. It is not intended to be exhaustive, or definitive but rather provide a preliminary view of the whole value chain and the interactions across it. This will provide the opportunity for additional research through hypothesis generation. The research is also designed to contribute to a discussion of moving from a supply chain orientation to a value chain orientation. This shift to a value chain orientation is one that contains the principles expressed by the concept of the offering, described by service dominant logic, and how this impacts food waste
Sections 4.2 to 4.5 provide an overview of the structure and regulatory context for the dairy industry. Sections 4.6 to 4.10 provides results from interviews on waste at different stages of the supply chain and section 4.11 provides a brief summary and synthesis of the findings.

4.2 Dairy Industry Supply Management – An Overview

The dairy industry in Canada represents a unique situation because unlike most food supply chains the sale of bovine milk is controlled and regulated by a supply managed system. Supply management is a tactic used by many countries such as Australia, the European Union countries, India, and others (van Duren, 2016) and while some while countries still use this tactic for specific products others, such as New Zealand and Australia, have moved away from supply managed dairy systems. Despite there being examples of this system for specific goods it is relatively uncommon and often is reserved for high value, high input products, such as animal products. In Canada, both bovine dairy and poultry have supply managed systems.

For bovine dairy, supply management is controlled through the Canadian Dairy Commission (CDC), the Dairy Farmers of Canada, and provincial marketing boards (Currie, 2017). In this case, the Dairy Farmers of Ontario (DFO) is the provincial marketing board of interest. The national system was pulled together in the 1970s but its roots stretch back much further to the 1920s, when small groups of dairy farmers banded together and created cooperatives to increase bargaining power (McCabe, 1985). Despite these early efforts, the cooperatives remained fragmented and by the 1960s there was significant
turmoil in the dairy industry with many farmers experiencing difficulty finding a secure living (Goldfarb, 2009).

The CDC was formed in 1966 to help stabilize income for farmers, despite oppositions from dairy processors. By the 1970s the CDC was federally recognized. The establishment of the CDC shifted the power away from the processors and towards the farmers, which helped farmers achieve better returns on their products. The CDC has two federally mandated objectives. They are:

- to provide efficient producers of milk and cream with the opportunity to obtain a fair return for their labour and investment; and
- to provide consumers of dairy products with a continuous and adequate supply of dairy products of high quality (Government of Canada, 2016a).

The CDC is a federal corporation that makes recommendations on national milk production as well as sets reference milk pricing levels. Provincial marketing boards, such as the DFO, view the reference levels set by the CDC and then set the prices for various milk product constituents for making items, such as cheese, in their given provinces. A milk component pricing strategy, also known as the Milk Allocation Policy, that is established federally as well as provincially, identifies classes of milk and how they can be used. These strategies suggest uses for milk classes and the 2017 update has been lauded as one to produce exciting new ways to use the less desirable skim milk that is produced in excess, as demand for butterfat soars (Greig, 2017). Despite the positive outlook for waste associated with the new milk component pricing
strategy, trade disputes between the United States and Canada over the renegotiation of the North American Free Trade Act (NAFTA) has created controversy over the new strategy, and class 7 milk in particular, with suggestions that provides an unfair advantage to Canadian dairy producers (Johnson, 2017). A resolution to this dispute has only recently been reached and dubbed the new U.S.–Mexico–Canada (USMCA) trade agreement. The signing of the USMCA signals the end of class 7 milk and the strategy built around it. This is problematic because the class 7 milk category was a means for less desirable milk products such as milk protein concentrates and skim milk powder, to be used up by allowing very low sale prices. These less desirable products from Canadian dairy were then able to be more competitive with imported Milk Protein Products (MPPs). MPPs have been deemed "protein substances" rather than dairy products by the Canadian International Trade Tribunal in 2005, exempting them from dairy quota and enabling the US to flood large quantities of the cheaper product on the market (Pearson et al., 2018). Milk class 7 was a response to this inflow of MPP and allowed Canadian products to be used up before turning to the American market. But trade disputes have changed this. In fact, on July 13, 2018, it was noted that the DFO had removed a description of class 7 milk from their website, indicating that the end of this milk class was predicted months before it came to fruition (Figure 4.1) (DFO, 2018a).
### Figure 4.1 Milk Classification Table as it appeared on the DFO website on July 13, 2018.

<table>
<thead>
<tr>
<th>Milk Class</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>Milk used to process milk, partly skimmed milk, skin milk, butter milk, or milk beverages for retail sale or use in a food service premises. Milk used to process flavoured milk, flavoured partly skimmed milk or flavoured skin milk sold at retail or used in a food service premises. Milk used to process eggnog or dairy cotta.</td>
</tr>
<tr>
<td>1B</td>
<td>Milk used to process cream, table cream, double cream or whipping cream for retail sale or use in a food service premises. Milk used to process flavoured cream sold at retail or used in a food service premises.</td>
</tr>
<tr>
<td>1B1</td>
<td>Milk used to process fresh cream with a butterfat content of at least 32% by weight to be used in making fresh baked goods if the Canadian Dairy Commission has issued a class 1B1 permit for the milk.</td>
</tr>
<tr>
<td>1C</td>
<td>Milk used to process a new product within the categories of products referred to in class 1A or 1B.</td>
</tr>
<tr>
<td>1D</td>
<td>Milk used to process products within the categories of products referred to in class 1A or 1B, if the products are processed for sale in the Yukon, the Northwest Territories or Nunavut or for use on an aircraft.</td>
</tr>
<tr>
<td>2A</td>
<td>All types of yogurts excluding yogurt beverages. Kefir and Lassi, excluding frozen yogurts.</td>
</tr>
<tr>
<td>2B</td>
<td>All types of ice cream and ice milk, ice cream mix and ice milk mix, whether frozen or not, other frozen dairy products including frozen yogurts. All types of sour cream, fudge, pudding, sour mix, mousse, coffee, cappuccino, ice cream, coffee milk, and mocha milk.</td>
</tr>
<tr>
<td>3A</td>
<td>Milk used to process cheeses other than cheeses referred to in classes 3B and 3C. Milk used to process cheese curds other than sour curds referred to in class 3B.</td>
</tr>
<tr>
<td>3B</td>
<td>Milk used to process cheddar cheese and cheddar type cheeses sold fresh, sour curd, cream cheese and creamy cheese bases or cheese mixes other than creamy cheese bases or cheese mixes used to process products referred to in another class.</td>
</tr>
<tr>
<td>3C1</td>
<td>Feta, Asiago, Gouda, Havarti, Parmesan, Swiss and Muenster.</td>
</tr>
<tr>
<td>3C2</td>
<td>Brick, Cheddar, Farmer's, Monterey Jack, Pepper Jack and all types of Mozzarella except when declared in Class 3D.</td>
</tr>
<tr>
<td>3D</td>
<td>Mozzarella cheese used in pizza prepared and cooked on site for the benefit of restaurant patrons. Mozzarella cheese, Part skim mozzarella cheese and part skim pizza mozzarella cheese, made in Canada.</td>
</tr>
<tr>
<td>4A</td>
<td>Milk used to process butter, butteroil, milk powders, yogurt powder or sour cream powder with a fat content greater than 4%. Milk used to process any product not within a category of products referred to in another class.</td>
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<tr>
<td>4B</td>
<td>Milk used to process condensed milk or sweetened condensed milk for retail sale.</td>
</tr>
<tr>
<td>4C</td>
<td>Milk used to process new milk products, other than new milk products within the milk product categories referred to in class 1C.</td>
</tr>
<tr>
<td>4D</td>
<td>Milk inventory and accountable losses at a plant.</td>
</tr>
<tr>
<td>4N</td>
<td>Milk used to process milk products that are processed for the surplus removal of milk or milk components and that are not exported within the limits for subsidized exports set out in Canada's Schedule to the World Trade Organization's Agreement on Agriculture if the Canadian Dairy Commission has issued a permit for the milk under the Special Milk Class Permit Program.</td>
</tr>
<tr>
<td>5A</td>
<td>Milk used to process cheese for further processing in Canada, other than by the confectionery sector, if the Canadian Dairy Commission has issued a permit for the milk under the Special Milk Class Permit Program.</td>
</tr>
<tr>
<td>5B</td>
<td>Milk used to process milk products, other than cheese, for further processing in Canada, other than by the confectionery sector, if the Canadian Dairy Commission has issued a permit for the milk under the Special Milk Class Permit Program.</td>
</tr>
<tr>
<td>5C</td>
<td>Milk used to process milk products for the confectionery sector if the Canadian Dairy Commission has issued a permit for the milk under the Special Milk Class Permit Program.</td>
</tr>
<tr>
<td>5D</td>
<td>Milk used to process milk products that are exported within the limits for subsidized exports set out in Canada's Schedule to the World Trade Organization's Agreement on Agriculture if the Canadian Dairy Commission has issued a permit for the milk under the Special Milk Class Permit Program.</td>
</tr>
<tr>
<td>6</td>
<td>Milk used to process skim milk components or condensed skim milk components, wet or dry, into an ingredient to be used in processed milk products. For example, skim milk powder, milk protein concentrate, or ultra-filtered milk.</td>
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4.3 Dairy Industry Structure

4.3.1 Canada

Nationwide the CDC represents 11,280 farmers, as of 2016. There are dairy farms in every province, but the majority are in Ontario and Quebec at 33% and 49% respectively. The province next in line, in terms of number of dairy farms, is Alberta with less than 5% of the total, indicating how compartmentalized milk production is in Canada (CDC, 2016c). The complete description of dairy farm distribution is shown in Figure 4.2.

Source: (CDC, 2016d)

Figure 4. 2 Distribution of dairy farms and dairy cows in Canada
The national number of dairy herds are decreasing, while number of cows per herd is increasing. Since 2002 the number of farms has decreased almost 63% (CDC, 2016c). Conversely, the average herd size has risen to 85 cows from approximately 76 cows in 2011 (CDC, 2017c).

Supply management helps standardize production strategies through governing bodies such as the CDC and DFO disseminating information to all farmers but there are several different production strategies that these bodies deem acceptable. These types of housing strategies include loose housing, tie stall (Figure 4.3), and freestall (Figure 4.4), and are all recognized as acceptable by the CDC.

A loose housing barn is an open space, contained within a building in which the cows are allowed to move freely. The floor surface is often a bedded pack where sawdust or fine wood is put down and changed infrequently. These types of facilities require minimal labour input and provide good cow comfort. Freestall barns are designed with stalls but the cows are not tethered and restricted only to their stalls, instead being free to move around. Tie stall barns are built with individual stalls for each cow in which the animals are restricted to their own stall through a tether and collar and rails on each side. One study that surveyed producers that transitioned from a tie stall operation to a freestall one reported being satisfied with the new configuration and survey participants reported higher satisfaction with implementing higher levels of automation such as using automated manure management instead of tractor scrapping (Bewley, Palmer, Jackson-Smith, 2001).
Recently there has been a marked increase in the number of freestall operations. This trend likely relates to animal welfare concerns, as well as the rise in use of robotic milkers (CDC, 2016b) which are more conducive to freestall barns. Interestingly, in Ontario and Quebec there are relatively few freestall operations, 30% and 7% respectively. All other provinces, expect PEI, have over 50% and up to 97% of their farms reported as freestall operations (CDC, 2016b).

The lower levels of freestall operations in Ontario may be associated with the high expense related to setting up a dairy operation. Ontario has traditionally had many more dairy farmers with many of these farmers running larger herd operations, compared to other provinces (CDC, 2016d). The higher number of cows per farm would possibly have helped justify more expensive infrastructure costs to achieve higher production and in the mid to late 20th century this meant building tie stalls facilities (Bewley et al., 2017). According to Bewley et al., the cost associated with building a new freestall facility, which are becoming more popular as herd size increases further, may be prohibitive and slowing the transition to these facilities in Ontario (2017). Næss and Stokstad suggest that larger dairy farms are most likely to invest more capital into barn infrastructure (2011). This seems to contradict the suggestions that large herd farmers in Ontario are slow to build new freestall operation due to their large size. But because the research by Naess and Stokstad did not discuss timing of investment it is difficult to know the period of time required to make these changes. It may be that Ontario dairy farmers are still in the middle of transitioning their infrastructure to freestall housing operations.
Despite the high costs associated with building infrastructure, labour is regularly reported to be a large financial investment. A 2016 evaluation of the cost of production (COP) changes in the dairy industry notes that labour is traditionally the driver of high COP. Interestingly, COP has decreased 2.1% between 2009 and 2017 (CDC, 2011; CDC, 2018a). Furthermore, the COP associated with infrastructure cost has decreased 9.2%, indicating that farmers may have room to use technology, such as automated robotic milkers and manure scrapers, to further decrease labour costs (CDC, 2011; CDC, 2018a).

The movement of cows are restricted, through collars and ties, to one stall that feed is delivered to and is cleaned regularly (GEA, 2017).

*Figure 4. 3 Tie-stall barn*
Automatic milking system where cows have free choice access to the milkers as well as stalls for resting (Lely, 2017).

*Figure 4. 4 Freestall barn*

In addition to different housing strategies, there are two main types of production strategies. Conventional production herds use tactics and methods at their disposal that are outlined as safe by the Canadian Food and Drug Act. This includes the use of approved drugs to treat sickness in animals as well as using feed grown in a conventional system. Conversely there are organic certified producers, only 77 in Ontario, that do not use most medications to treat their animals, do not feed crops grown in a conventional manner, and must provide pasture at least 30% of total dry matter intake. In addition to this there are numerous additional and more nuanced differences outlined by the Canadian General Standards Board (CGSB) in the Organic Production Systems Principles.
and Standard (the Standard) (CGSB, 2018a). In recent years, the demand for organic products have been increasing faster than the production of organic dairy has been increasing (CDC, 2017d). As a result of this increasing demand organic producers often receive more incentive days\(^3\) (DFO, 2017a) to make up for short falls in production.

\subsection{4.3.2 Quota}

There are two important forms of quota in the Canadian bovine dairy industry. Producer quota is what farmers need to sell milk in Canada and the value is determined by a quota system built in terms of kilograms of butterfat produced per day. Processor also use a form of quota as described by the Milk Allocation Policy (DFO, 2017b). The Milk Allocation Policy is built, in part, around classes of milk (Figure 4.1) with class 1 and 2 being marketed on-demand and the balance of milk being allocated based on the Plant Supply Quota (PSQ) Policy. The PSQ gives processing facilities the ability to purchase class 3 to 5 milk (DFO, 2017b). Quota is similar to a license and it allows production or purchasing of certain amounts of milk in a given period of time.

Interestingly, although producer quota is allocated based on daily production levels, in Ontario at least, it is measured cumulatively for the month and then divided by the number of days in the month. For example, a farmer will be measured to have produced 3,410 kilograms of butterfat over the month of

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\(^3\) Production volume bonuses given to dairy farmers when demand outstrips supply. They are allocated as a number of days, typically between 1 and 3, offered for additional production on top of the farmers existing monthly butterfat quota.
December. This means that the farmer must own at least 110 kilograms of quota (3,410 kg/31 days = 110 kg of butterfat/day) to avoid overage shipping charges associated with hauling excess milk. There is room to build up excess quota from under production occurring in previous months. There are, however, limits on the amounts that can be built up that are outlined by the provincial marketing boards. Some farmers take advantage of this system to avoid overages.

Quota was initially freely allocated to farmers based on their historic production when the system was first implemented but since then a cost has been put in place and it has risen steadily (Heminthavong, 2015) until a cap on the price was placed. In Ontario, cost of quota was capped at $25,000 per kilogram of butterfat as of 2010 but was decreased to $24,000 per kilogram of butterfat in August 2015 (DFO, 2017c). Since then the price in Ontario has remained consistent at the capped level of $24,000/kg of butterfat.

In addition to purchased producer quota there are incentive day’s quota as well as gifted quota. These forms of quota are designed to make up for shortfalls in production in relation to demand and do not cost the farmer money. During incentive days the DFO offers extra quota communicated as a percentage of each farm’s existing quota. Conversely, gifted quota is a permanent irrevocable amount of quota added to a farmer’s daily production allowance. As previously discussed, there are 11,280 holders of dairy quota in Canada and 3,731 dairy quota holders in Ontario. This number is continually decreasing as small farms are bought and large farms increase their volumes by purchasing small farmer’s quota shares.
Processor quota is a less commonly talked about form of dairy quota. It is similar to producer quota in that it is a prescribed amount of milk. Processors are allowed to manipulate this milk and sell the resulting products. Unlike producers, the majority of milk, 60%, is allocated on-demand to processors using class 1 or 2 milk, which are the most expensive classes of milk (DFO, 2017b). Conversely, processor using class 3, 4, and 5 milk must have quota for their milk. Like producer quota, the marketing board offers under production credits that processors can fill during times of heightened availability and processing capacity (DFO, 2017d).

In Canada, there are 270 dairy processors registered federally, with this number decreasing about 4% between 2007 and 2017. There is a trend of decreasing total numbers of processors while size of individual operations is increasing. This is similar to what is happening with dairy farms. The number of operations is shrinking as existing companies amalgamate and combine facilities. Unsurprisingly, the dairy processors are primarily physically concentrated in Ontario (139) and Quebec (193) (CDC, 2017b) where milk production is highest.

4.4 Changing Consumer Demands and Potential for Waste

Changes in the dairy industry and consumer demand preferences are important considerations when looking at sources of waste. Most notably the appetite for butter and cheese has increased between 1998 and 2017 by 89 and 83% respectively (Government of Canada, 2018a) while consumption of skim milk and fluid milk (3.25%, 2%, 1% butterfat) in general has decreased between
58 and 76% from 1998 to 2017 (Currie, 2017; Government of Canada, 2018b).
Furthermore, the average dairy herd size is increasing while the number of dairy farms in Canada and Ontario are decreasing, which impacts the speed with which industry reacts to consumer shifts (van Duren et al., 2016).

The dairy industry in Canada is ranked third in overall value for the agriculture industry, pulling in over $6 billion for the economy. This ranking is helped by increased efficiencies gained through fewer farmers farming larger herds with cows also producing more milk\(^4\) (Statistics Canada, 2017a). Increased per cow milk production is largely achieved through research into better cow genetics for production and this research is afforded through funding initiatives through marketing boards and the CDC.

Despite the productive capabilities of the dairy industry, more products are imported than exported, with Canada importing 118% more dairy products then we export (Table 4.1). Our primary export partner is the United States, with a large trade deficit existing (Government of Canada, 2018c). Canada also exports to other nations, but the majority of our products remain domestic. Canada protects the supply management system with a series of import quotas and tariffs.

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\(^4\) Average production for cows in Canada in 1986 was 5.0 Kiloliters of milk sold off farm for every dairy cow on census day compared to 9.0 Kiloliters of milk sold off farm for every dairy cow on census day.
### Table 4. 1 Quantity (kg) and Value (Canadian $) of Imports to Canada and Exports from Canada

<table>
<thead>
<tr>
<th></th>
<th>2017 Imports</th>
<th>2017 Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity (kg)</td>
<td>Value ($)</td>
</tr>
<tr>
<td>Milk</td>
<td>41,239,166</td>
<td>20,083,833</td>
</tr>
<tr>
<td>Cream</td>
<td>3,775,742</td>
<td>15,998,185</td>
</tr>
<tr>
<td>Cheddar and Cheddar Types</td>
<td>3,084,248</td>
<td>34,448,520</td>
</tr>
<tr>
<td>Specialty Cheese</td>
<td>22,271,100</td>
<td>276,693,514</td>
</tr>
<tr>
<td>Processed Cheese</td>
<td>861,541</td>
<td>8,506,321</td>
</tr>
<tr>
<td>Fresh Cheese</td>
<td>1,375,922</td>
<td>8,907,930</td>
</tr>
<tr>
<td>Ice Cream &amp; Edible Ice Products</td>
<td>879,960</td>
<td>3,037,433</td>
</tr>
<tr>
<td>Yogurt</td>
<td>640,491</td>
<td>3,480,086</td>
</tr>
<tr>
<td>Butter and other fats and oils</td>
<td>20,652,502</td>
<td>131,101,462</td>
</tr>
<tr>
<td>Evaporated Milk</td>
<td>1,194,633</td>
<td>1,341,122</td>
</tr>
<tr>
<td>Condensed Milk</td>
<td>23,131</td>
<td>59,312</td>
</tr>
<tr>
<td>Skim Milk Powder</td>
<td>3,657,309</td>
<td>10,205,111</td>
</tr>
<tr>
<td>Whole Milk Powder</td>
<td>2,516,622</td>
<td>8,789,277</td>
</tr>
<tr>
<td>Whey Products</td>
<td>29,943,095</td>
<td>87,167,458</td>
</tr>
<tr>
<td>Casein and Casein Products</td>
<td>3,461,221</td>
<td>32,563,314</td>
</tr>
<tr>
<td>Dairy Spreads</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Products Consisting of Natural Milk Constituents</td>
<td>3,347,959</td>
<td>18,211,149</td>
</tr>
<tr>
<td>Milk Protein Substances</td>
<td>34,127,274</td>
<td>91,465,529</td>
</tr>
<tr>
<td>Others</td>
<td>13,653,193</td>
<td>120,406,602</td>
</tr>
</tbody>
</table>

**TOTAL** 186,705,110 872,466,159 171,816,442 398,885,649

1 Data taken from Government of Canada, Canadian Dairy Information Centre (2017c)

2 Data taken from Government of Canada, Canadian Dairy Information Centre (2017d)
Ontario and Quebec are the clear majority producers in the country and therefore drive many of the decisions and changes made to the national supply management program. The marketing boards of Ontario and Quebec, the Dairy Farmers of Ontario, and Les Producteurs de lait du Québec respectively, drive and often lead changes made to the industry nationally. For example, Ontario was an early adapter to an altered milk ingredient strategy in order to incentivize increased use of the less desirable and surplus components of milk, such as skim milk powder (Briere, 2018).

The need for an altered ingredient strategy is a result of changing consumer preferences for milk components. In the 1980s and 1990s it was suggested that fat was a deleterious health product and that consumers should avoid it (La Berge, 2008). This resulted in lower demand for butterfat products and an increased consumption of “health conscious” dairy products such as low-fat milks, with 2% milk sales peaking in 1988, and 1% milk sales peaking in 2000 but since then both have declined 45 and 22% respectively by 2015 (Statistics Canada, 2017b). More recently, new evidence has arrived that suggests an impact of lobbying by sugar producers to control the dissemination of research about sugar’s deleterious health implications. Lobbying efforts helped suppress this information and efforts were made to keep discussions focused on potential for a relationship between fats, heart disease, and obesity (O’Connor, 2016; Kearns et al., 2016). This revelation, combined with publication of favourable reports on the benefits of some fats (Kratz, Baars, & Guyenet, 2013; St-Onge, 2005; Yakoob et al., 2014) seems to have increased demand for fatty products.
including butter, cheese, and ice creams. This has led to an unfortunate consequence as sales of skim milk, a byproduct of skimming milk fat, decreased 45 and 22% (Statistics Canada, 2017b) and demand for high butterfat items such as cheese and butter has increased by 5.6 and 4.5% respectively (VanRaes, 2017), leaving more low-fat milk behind. Because of this more waste skim milk is produced. To understand how fat is gleaned from whole milk Figure 4.5 is presented to show the breakdown of the milk’s constituents. Fat, the most desirable component at the time of this research, is clearly the lowest constituent, with milk solids which include various proteins and sugars, represents the second fraction.

Figure 4. 5 General composition of milk
All these changes and the interactions within this complicated system have the potential to influence milk recovery or loss. What follows is a discussion of the elements of the supply chain that impact wasted milk, as described in interviews with ten dairy farmers, six dairy processors, three dairy marketers, two dairy truck drivers, and eleven retailers of dairy products. The following discussions will track milk and any associated waste through the dairy supply chain, as described by industry participants at all levels interviewed between November 2016 and November 2017.

4.5 The Dairy Industry Supply Chain

The dairy supply chain (Figure 4.6) in each province in Canada looks different than most other supply chains due to the presence of supply management. Supply management means a provincial marketing board, in Ontario the Dairy Farmers of Ontario (DFO), exerts influence and control over the movement of milk from farm to processors.

The diagram in Figure 4.6 depicts the general flow of products and information in the milk supply chain. The following sections use this understanding as a framework to identify where waste occurs as well as, why, and how this waste occurs. It also addresses how contributors to waste might be mitigated and which management principles could be implemented for waste reduction.
Dairy specifically, and animal products in general, are expensive products to produce relative to most vegetable, fruit, and grain crops. This is substantiated by a price comparison of food products tracked by the government of Canada and adjusted to compare prices on a calories/kg basis (Figure 4.7). Farmers pay high prices for the feed required to allow their cows to produce milk as well as for animal health care experts such as veterinarians, nutritionists, and insemination technicians. These experts are required to ensure that herd health is optimal, and cattle are inseminated with semen from bulls of high caliber. The aim is to
continually improve the dairy herd so that milk production is always as high as possible. Canadian data on per cow changes in production over the years shows that between 2001 and 2017 per cow milk production for Holsteins has increased almost 16% to 10,756 kg of milk per year in 2017 (CDC, 2017c; Statistics Canada, 2018a). Once leaving the farm, because of the vulnerability of milk to temperature increases above 10°C (DFO, 2018b) as well as complexities of supply management, product can be lost at multiple points when failures in the supply chain occur.

Figure 4. 7 Comparison of the cost/calorie/kg of common food products tracked by the government of Canada. Products in yellow are dairy. Data is extracted from Statistics Canada Table 18-10-0002-01 (2018a).
4.6 Farm Waste

In this section, an evaluation of where waste is occurring on farm will be carried out. It will include discussions of waste that occurs in high and low volumes and examine areas where change could be implemented with relative ease as well as areas that require more significant effort to decrease waste production.

4.6.1 Treated Cow Waste

A treated cow refers to an animal that has been given medication to treat an ailment or influence fertility and milk production. The types of treatments vary but can include antibiotics, pain Killers, anti-inflammatory drugs, and hormonal treatments. These are given to deal with issues such as retained placenta, mastitis, and difficulty calving.

Milk is wasted due to treatments because most medications used on farm come with a required time when the milk is not allowed to enter the milk tank. This withdrawal time allows medication to be metabolized and ensures that the milk for human consumption has no significant trace of antibiotics in it. This is referred to as the withdrawal time. Withdrawal times vary but common issues such as mastitis are often treated with antibiotics such as penicillin which requires a withdrawal time of 48 hours after cessation of the last treatment. This means that milk that would have moved from the farm up the supply chain cannot continue on and must be used in other ways or disposed of.
Interestingly, some farmers divert treated milk to feed their calves as a way to reduce waste and be more efficient. Some farmers are refusing to feed this milk to calves. Calves have immature immune systems and feeding treated cow milk to these young animals is thought to potentially decrease the likelihood that they will survive and thrive during their milking years (Langford, Weary, & Fisher, 2003). One organic farmer commented he occasionally had a few pigs he fed treated milk to but explained that was not part of an organic protocol and he had to have enough people interested in the meat, so it was often difficult to justify. A review of the CGSB Standard does not directly indicate a problem with this practice but does describe that livestock labeled organic should be given feed containing “100% organic agricultural ingredients and necessary feed additives or supplements” (2018a). Milk from a treated cow would not meet this standard.

Additionally, another dairy farmer interviewed suggested that feeding a young calf treated milk from a mastitis cow was common practice but a very bad idea due to the weak immune system of the calf. Other interviewees also suggested that milk from treated cows can be made better through pasteurization but even when this is done, the treated cow milk is not an optimal feed substrate for calves. The reluctance to feed pasteurized treated cow milk to calves may be related to research that has indicated some forms of pasteurization can have detrimental impacts on the presence of protective immunoglobulins (Ig) in
colostrum.\textsuperscript{5} Despite this Godden (2008) points out that colostrum pasteurized at lower temperatures, 60°C instead of 63°C or 72°C, for longer, sixty minutes instead of thirty minutes or fifteen minutes, yields colostrum with acceptably high levels of active Ig. Also, a review of the literature did not provide any research indicating that feeding pasteurized milk after the first twenty four hours of life produced any deleterious effects. Interestingly, some research has shown that pasteurization successfully controls infection rates of calves fed pasteurized milk from cows carrying several specific pathogens and these calves performed at rates comparable to calves fed uncontaminated milk (Aust et al., 2013; Butler et al., 2000). Despite the presence of this information, none of the farmers interviewed said they pasteurized their treated cow milk – although one farmer indicated they would like to but do not have access to the proper equipment. In general, of the other farmers interviewed, six described dumping treated cow milk as a waste product and three said they fed the treated cow milk to calves.

Interestingly there are two typical treatments for mastitis, one of the most common ailments that requires antibiotics. One of these treatments is Excenel RTU, brand name for ceftiofur hydrochloride, and it does not require any withdrawal time, but it is very expensive. It was suggested by interview subjects that most farmers choose to use this product thinking that in the long run it will save them money because the cow can remain within the milking herd. Farmers

\textsuperscript{5} Colostrum is the first milk produced by the cow. It is important because bovine placenta does not allow the transfer of immunoglobulins in utero and therefore the colostrum delivers the protective enzymes to defend against environmental pathogens and that pass through the calves’ permeable small intestine in the first 24 hours of life (Godden, 2008)
seem to be preoccupied with getting the milk from the cow out the door to the processor. But, at least one farmer interviewed believes that this is flawed thinking because the cost to treat a cow with penicillin, that requires withdrawal times, is so much lower it more than makes up for the lost funds from not getting milk from the treated cow to market. Without direct data this is hard to prove but based on communication with a Southern Ontario vet it was determined that the price of a bottle of Excenel is about $350 and a bottle of penicillin is about $30 (Kourtney Rivers, DVM, Personal Communication, 2018). This information says nothing about the real cost per treatment as dosage varies based on the specifics of the illness, but it can be said that optically it is easier to appreciate the apparent thrift of using penicillin.

It was suggested by one dairy farmer interviewed that more proactive and typically younger dairy farmers calculate the cost of treatment using ceftiofur hydrochloride, versus the cost of treatment using penicillin. Penicillin requires a 48-hour withdrawal time but because of the low cost upfront of penicillin it is a more cost-effective solution despite the loss of the withdrawal milk. It is therefore the economically incentivized option. This treatment option, however, necessitates wasted milk.

Interestingly three dairy farmers noted that few farmers are treating with penicillin. It seems that although there may be a new generation of farmers, that may be more savvy managers, who are more likely to do the calculation that shows the cost advantages of treating with penicillin, these farmers are still in the minority. In terms of waste, this is a positive thing, but it may be only a short time
before other farmers identify this potential cost saving. This realization may be economically helpful for farmers but it is not ideal in terms of waste generation. Pushing for antibiotics with shorter or absent withdrawal times that can be sold at lower price points could provide a viable solution to this avenue of waste generation in dairy farms.

The Government of Canada produces a list of medications, including antibiotics, and their withdrawal times for production animals. This list shows 17 antimicrobials listed as having no withdrawal time required for various production animals, but none are labeled for use in lactating dairy cows (Government of Canada, 2016b). In the US, erythromycin is used for lactating dairy cows and when injected requires no withdrawal times (Jones, 2009) but Canada has only listed erythromycin for use in breeding chickens (Government of Canada, 2016b). Early research by Ziv has shown that antibiotics have low binding capabilities to milk proteins and udder tissue (1980) indicating there may be additional, untapped options for treatment among other antibiotics with low or absent withdrawal times in other animals. Furthermore, because withdrawal times are implemented due to the cow shedding antibiotics in their milk, producing treatments that have reduced withdrawal times has the added advantage of reducing the shedding of antimicrobial residues into the environment. Therefore, using treatments with lower or absent withdrawal periods may be more environmentally sensitive and can help decrease the development of antibiotic resistant bacteria that form, in part, in association with farm run-off contaminated with antibiotics (National Research Council, 1980).
A final issue that links to the presence of antibiotics in the environment and the development of antibiotic resistance is the practice of spreading raw, unsalable milk on fields. One farmer commented that he would spread treated cow milk on his fields because it “returns some of the nutrients back to the land” (Dairy Farmer 1, 2017). The conversation with this farmer indicated that he did not view this as a waste activity but as a way to produce utility with product that could not move further in the supply chain. This practice wasn’t discussed by other dairy farmers, so it is difficult to speculate how common the practice is amongst interview subjects. The subject is discussed in many trade publications describing the practice of spraying raw milk on pastures, with varying levels of confidence in the outcomes (Greaney, 2010; Grubbs, 2016; Hisley, 2013). A few academic publications have looked at this practice and describe it with limited optimism (Jamison-Hilshey & Bosworth, 2014). Although there does not appear to be a general consensus on the efficacy of spraying milk on fields the presence of the debate does seem to indicate that farmers can have high enough volumes of unsalable milk that disposal can present a problem. Spreading it on the field may or may not help pasture and crop growth but based on evidence from the National Research Council it seems likely that treated cow milk can contribute to the development of antibiotic resistance (1980).

The issue of withdrawal time and wasted milk represents a technological failure as we are unable to provide farmers with medications with very short or no withdrawal times, such as ceftiofur hydrochloride, that are at a price point low enough to ensure its use by economically rational farmers. Increased research
efforts to streamline the production of ceftiofur hydrochloride to reduce costs would be useful. The subset of the farming community that has decided that penicillin, despite its withdrawal time, is the best option is small but was reported to typically be younger farmers. As more young farmers enter the industry it may become more common to use cheaper options with withdrawal times, such as penicillin. Therefore, waste prevention advocates should be pushing for cheaper treatment options with no withdrawal times.

4.6.2 Incentive Days

The dairy supply managed system pays producers based on the amount of quota they own. Quota is given in terms of kilograms of butterfat. Production levels at each farm are calculated at the end of the month based on the calculated sum of every pickup, with pickups typically occurring every other day.

When it is noted that there is a need for more milk in the system, a more common occurrence since the demand for butterfat has increased, the DFO offers extra quota communicated as a percentage of each farm’s existing quota. For example, if a farm has 110 kg of quota and the DFO offers one incentive day for the month of September, that allows the farmer to produce up to 5% over the existing quota that they own. This means that this farm can produce an extra 5.5 kg of butterfat per day in the month in which the incentive day is offered. This may seem like a small amount in terms of volume of milk, but if a calculation is done based on 3.95% butterfat, a 5% incentive day increase in quota means a farm is able to produce and be paid for an extra 139 kg of milk or approximately
135 liters of milk. What a farmer can get paid for this varies based on the new pricing strategy but as of July 2017 the pricing strategy would pay $0.72 per liter for the average composition on milk. This means that the average farmer can bring in an extra $3,017.85 for a typical 5% incentive increase (see Table 4.2). This number will double if two incentive days are offered and triple if three incentive days are offered.

At these numbers, it is easy to understand why farmers are interested in being ready to produce for incentive days. This mean, if using an average cow production of approximately 33 liters per day, an average dairy farm needs to bring an additional four cows online to meet this increased quota allowance. Because the payoff for this increase is high, farmers may try to be ready for incentive days by predicting when the next one will come and ramping up their cows to meet the increase in quota available to them. Because of the long gestation length required for a cow, 283 days, this can mean that they may make a poor prediction and be left with extra milk when incentives days do not arrive when anticipated.
Table 4. 2 Calculations for the value of incentive days offered by the DFO for the average Canadian dairy farmer

Key Information:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is 3.95% butterfat, 3.25% protein, and 5.6% other solids in raw fluid milk (Government of Canada, 2017a)</td>
<td></td>
</tr>
<tr>
<td>There is are 85 cows in the average Canadian dairy herd (CDC, 2017c)</td>
<td></td>
</tr>
<tr>
<td>The average Canadian dairy cow produces 32.7 liters of milk per day* (Government of Canada, 2017a)</td>
<td></td>
</tr>
<tr>
<td>For a liter of milk, in July 2017, the average Ontario farmer could expect to be paid $0.72**</td>
<td></td>
</tr>
<tr>
<td>One kilogram of quota typically costs $24000 and was capped at that price for Ontario and Quebec in 2010 (Heminthavong, 2015)</td>
<td></td>
</tr>
</tbody>
</table>

Calculations:

85 cows x 32.7 L/day x 0.0395 butterfat = 110 kg of quota**

110 kg x 0.05 = 5.5 kg of incentive-based quota

5.5 kg/0.0395 butterfat = 139.2 kg of extra milk

139.2 kg /1.03 = 135.2 liters of extra milk*

135.2 L x $0.72 = $97.34

$97.34 x 31 days of the month = $3,017.54 for one incentive day – this number doubles for two incentive days, triples for three incentive days, etc.

*Conversion: 1.03 kg of milk = 1 liter of milk

**Farmers buy quota as a daily allowance to produce butterfat, but milk collected is measured against production allowed on a monthly basis

***Calculations based on (DFO, 2017e)
In general, incentive days represent a rational approach to meet increased demand in the supply chain. Furthermore, farmers are behaving rationally by predicting the arrival of incentive days and ramping up their herd production accordingly, so they can be paid for the additional volume. Unfortunately, when incentive days were introduced by the DFO it was not anticipated that they would have an impact on waste generation on farm. There are two avenues that cause increased waste due to incentive days:

1. Herd size: Large herds are more likely to produce waste due to a lack of nimbleness and the scale of their milk production.

2. Distrust of the processors and unwillingness to pay shipping overages

Herd size appears to have a large impact on waste generation when it comes to incentive days. A small herd can more easily respond to additional quota offerings by keeping low producing cows in milk longer than originally intended, then decrease production by quickly culling those cows when incentive days end. A large dairy on the other hand, cannot respond to changes as quickly because their volume is much higher and therefore a 5% increase in quota represents many more cows. It takes more time to get this increased number of cows producing and similarly, it takes time to organize a cull of a large number of cows after incentive days have passed. Furthermore, large dairies are more incentivized to be ready for incentive days so they can be paid for extra milk whenever possible. A 5% increase on 110 kg of quota is a substantial amount, but a 5% increase on 600 kg of quota is more substantial at $16,458.15,
calculated using the values in Table 4.2 for one incentive day. Farms with large herds are understandably unwilling to risk losing out on such large payouts. Several interview subjects including three of ten dairy farmers and two of two dairy truck drivers reported that large farms stay ready for incentive days by having their herd producing over their quota allocation more often. Interview subjects suggested that when this is done the excess is shipped, at a cost to the farmer, or dumped at little to no additional cost to the farmer.

The assertion that milk is dumped because farmers would like to be ready for incentive days is difficult to substantiate using existing industry and academic data. Determining the validity of this would require quantitative data collection on farm, which is outside the scope of this study but encouraged for future research. It was also not possible to gather data on how often farmers ship overages on their quota each month. This information is likely tracked by shipping companies but was not accessible for this research.

Unfortunately, this system also means larger amounts of waste will be generated when big dairy farms reach the end of their incentive days but find they have excess milk according to their total quota allotment. This is related to the way quota is measured. As described in section 4.2.2., pick-up volumes are totaled for the month and then divided by the number of days in the month to determine if quota has been met, exceeded, or not met. This means that during an incentive days month farmers will know by the end of the month if they are on track to exceed their allotted quota. If at the end of the month a farmer realizes production will surpass their quota then the farmer can decide to ship the excess
and pay the overage charges or to dump enough milk so their total volume for the month is at an acceptable level. Faced with this choice, it is suggested that many choose to dump volumes of milk at the end of the month. See, that is the problem. I would think that that's one of the biggest problems because it's very hard to get a bunch of extra milk the next day. So, and like I said that's why guys are dumping milk on a regular basis because then they have it available and as soon as those incentives come in. And with cow's calving and stuff like that, it's very, very hard to manage. (Dairy Truck Driver 1, 2017)

This issue was repeatedly emphasized by Dairy Truck Driver 1, who in the past had run his own dairy farm, but it was also corroborated by other dairy farmers including Dairy Farmer 11 who said, "it makes more sense to dump the milk now and keep the cows going" (2017). Although some interview subjects discussed this issue, many others would not discuss it in clear terms. Dumping was alluded to with gestures and facial expressions, but it was difficult to obtain direct answers. This may be related to feelings of guilt associated with the waste of milk. At least one other farmer interviewed expressed guilt over having to dispose of milk. Additionally, past research has found that for 78% of participants surveyed guilt is at least “a little” of the factor that influences them to reduce their waste (Quested et al., 2013). Farmers that identify with this emotion may be less inclined to openly admit to dumping milk because of the association with wasting food. Importantly, because the issue of farmers dumping overages was only clearly exposed part way through the interview data collection process, this information was not pushed for early on so it is difficult to know how many farmers of those interviewed would have corroborated these findings.
Despite this the scale of the potential problem, in terms of waste production, becomes more apparent when you consider that the average dairy herd size in Ontario and Canada is increasing steadily (CDC, 2017c). This makes it an important issue to rectify as waste production will increase as more incentive days are offered to deal with increased demand for butterfat.

The second issue that contributes to waste and is associated with incentive days is a general distrust of the processors. Farmers are hesitant to ship their extra milk because not only are they required to pay the added shipping costs, but they are also not paid for that extra product, while they believe the processor will receive it for free.

Not too many people like to over ship…. Because you're paying to ship it and you're getting nothing for it. It's costing you money … [you have to think that] "Okay, but those guys are going to send extra milk then the processors are going to have that milk and you're not going to get extra quota. You're not going to get paid."(Dairy Truck Driver 1, 2017)

Some suggest this system works as a disincentive for processors to pay farmers for added quota because despite higher demand they believe that processors are getting the overages some farmers ship, instead of dumping, at very low costs. And in that way, it encourages the continued use of incentive days because processors get access to some very cheap milk.

And so that's kind of the problem I think ... Because that's what they say about the guys that do ship it [their overages]. You're not helping yourself because you ship it. Giving it to them [the processors] is less incentive for them to come looking for more milk. (Dairy Truck Driver 1, 2017)

The issue of mistrust for the processors is echoed and alluded to throughout the supply chain. Some suggest that increased communication from
them would help reduce this. Others would like to see transparency about where their milk is changing hands and for how much money in order to regain some faith in the system.

I think it would just be that transparency of the milk that went to market, how much of it went through the processors to be used. If I was shown on a wall somewhere, on a large screen, on a website, that would be more exciting. But that would be on the processors again… Yeah. So, if you could track your truck - say you had an app that showed you where your truck went, when it emptied, at what processor, and then the processor sent the information back about how they used it. (Dairy Farmer 10, 2017)

Another farmer explained that “you need to be confident that this extra milk isn't making them (the processors) a ton of money or whatever yeah but sometimes I think it is” (Dairy Farmer 9, 2017). Both communication and transparency are likely to help but it is difficult to predict how much this will impact waste generated from dumping overages at the end of an incentive days' month.

Importantly, incentive days are likely here to stay. The demand for milk fluctuates based on the time of year – in the fall there is a surge in demand related to back-to-school and upcoming holidays such as Thanksgiving and Christmas. A review of the incentive days information for farmers provided by the DFO shows that between January and July 2017, one incentive day for conventional farmers and 3 for organic farmers were offered. Conversely, between August and December 2017 an average of 2.4 incentive days were offered to conventional farmers and 5.4 incentive days were offered to organic farmers (DFO, 2018c). In the spring and summer demand decreases. This presents an issue because improved genetics, better farm management, and
nutrition allow cow production to be fairly consistent year-round; steady production levels are more efficient for farmers. But meeting the high demand in the fall season at a consistent price is difficult without increased production. It may be possible that if a policy of consistent incentive days were implemented it would help address some of the waste. However, because incentive days are designed to be a quick response to fluctuations in demand, it is likely that consistent incentive days would produce some level of waste at the processor and retail end when demand is forecasted incorrectly. A review of incentive days for conventional farmers between 2007 and 2017 shows that although there tends to be more incentive days in the fall with an average of 1.69 days between August and December and 0.42 days between January and July, this is not consistent and occasionally there are no incentive days on a particular month in the fall (DFO, 2018c).

Some farmers suggest that marketing campaigns need to be implemented to increase demand in low seasons and that “we need to encourage people to eat more ice cream (and other dairy products) year-round” (Dairy Farmer 11, 2017). With obesity and disease related to excess calorie and sugar consumption levels on the steady increase in Canada (Statistics Canada, 2014) the suggestion that consumers need to eat more ice cream becomes a difficult one to defend. One solution may be to allow for demand-based pricing that would disincentivize over consumption when demand is high and maintain dairy’s status as a valuable product that requires significant effort and resources to produce. The concept of demand based pricing for dairy products is bolstered by a 2010
systematic review showing multiple dairy based products are price elastic (Andreyeva, Long, & Brownell).

The challenges of waste associated with incentive days is a failure of the system. The dairy system has been set up to primarily produce quality milk and provide financial security for farmers (Government of Canada, 2016a). Within this structure waste is being produced because of the volatility of demand. Further investigations into waste production as a result of incentive days as well as refocusing dairy policy to include waste reduction as a key tenet are advised. It would be useful to compare waste associated with demand fluctuations in Canada to what happens in the USA, a non-supply managed system. Currently no such investigations exist, and future investigations are encouraged.

4.7 Dairy Truck Driver Associated Waste

For milk to leave the farm, insulated milk trucks arrive, typically every other day, to empty the on-farm storage tank. This process is fairly efficient. The truck arrives on farm, the driver does a visual and smell inspection of the milk house and the milk in the tank. The driver also checks to make sure the milk is being held at the correct temperature which is ideally between 1 and 4°C but must be rejected immediately once it reaches 10°C (DFO, 2018d). A sample from the milk tank is taken to be submitted to the lab to ensure the batch of milk does not contain harmful bacteria, antibiotics, or other contaminants. If the milk truck driver is content with the visual and olfactory inspection the milk is pumped into the truck’s holding tank. The movement from farm tank to milk truck tank typically
results in little waste. The only waste that was reported by interview subjects to occur at this point is related to milk quality issues. If the farm tank has obvious debris floating in it or there is an off smell the driver will not take it and the farm tank will be dumped. Because this represents a large financial loss most farmers are very careful to avoid these issues, with many interviewees reporting that this type of situation had only occurred once in their memory, sometimes only once across multiple generations.

Another issue that contributes to milk loss, related to dairy truck pick up, is weather. Some farms, particularly those located in snow belts, have instances where the milk truck cannot make it to their farm due to poor driving conditions.

So, we live in Grey County, in the snow belt and it never stops snowing from November to April … and in the last two to three years the winters have gotten a lot harsher and the road restrictions that the insurance and liability and the MTO\textsuperscript{6} – they shut roads down here all the time … it’s illegal for the milk truck drivers to go on the roads [when they have been shut down], and not safe either. But back in the day, I’ve heard stories about tuckers going on the road in horrendous conditions. But now in the past two to three years, us having to dump milk in the winter is something that happens… We’ve had to dump whole tanks, which is ridiculous. We’ve had to dump half tanks before, because sometimes when you know the truck is coming you can just dump a little so they can come pick it up while it’s still within the three-day window. … Our goal is to never dump milk – we call it liquid gold and you want cry when you have to dump the milk down the drain. We lose all that milk and the money. (Dairy Farmer 1, 2017)

Although this farmer indicated dumping happens, the full scope of this problem is not known. Additional research needs to be done working with farmers and milk transportation companies to collect specific quantitative data on milk dumping on

\textsuperscript{6} Ministry of transportation
farm, related to weather issues. This will help to identify the urgency of the need for a solution to this problem. Currently, some farmers add storage capacity to their on-farm holding tank(s), but milk can only be stored on-farm for up to three days. After this period there is a risk that the tank of milk will have grown unacceptable levels of bacteria – farmers then risk contaminating the whole milk truck tank.

All farmers work fervently to avoid contaminating a truck load of milk because if they do cause a truck to have a contaminated load, they become responsible for paying for the whole thing. If we use the value of $0.72 per liter referenced in Table 4.2 and apply it to the smallest milk truck capacity of 13,000 liters the bill would be $9,360. Some larger trucks carrying up to 40,000 liters would result in a bill of $28,800 for a contaminated load. Because of this steep penalty farmers are extremely wary of shipping potentially risky product. It is safer to dump a small tank on farm than risk contaminating a larger load of milk. Dairy Farmer 9 explained that “I've never seen it. And I don't think my dad's ever seen it. That's pretty bad - something's got to be really wrong if that happens" (2017).

This high aversion to contaminating a load of milk, due to the significant financial cost, may be a useful incentive for reducing food waste. It is possible that it is better that a relatively small batch of milk is lost on farm than a large volume off farm. Once the milk has been added to the truck and shipped, not only is the milk lost in larger volumes, but more energy inputs have gone into moving it to the next step in the supply chain. To determine which situation truly
represents the least amount of loss additional research is needed to evaluate volumes of milk lost as well as the energy inputs contributing to their production.

Losses associated with milk truck movement largely represent technological failures. When a truck is unable to pick up milk from a farm due to weather it is because of insufficient transportation technology to make sure movement is safe. Outfitting transporters with better vehicles and technology to safely traverse inclement weather may contribute to decreases in wasted milk. Importantly, even if this is done, if a road is closed due to weather conditions it likely will not matter what type of equipment the driver has been provided. Further research is also needed to investigate the feasibility of this by analyzing the financial investment needed compared to the value of the waste prevention.

4.8 Processors

4.8.1 Butterfat Incentives

At the processing end milk can be lost for multiple reasons. These reasons are classified in this case as primarily system failures. Beyond this description, we can deepen our understanding of waste by describing it in terms of more specific system failures. Specifically, there is:

- Waste associated with inefficiency in operations and management issues.

- Waste produced because of the low cost of the end unit and the cost to bring that product to market.
Typically, larger processors have the financial and human resources available to invest into efficient systems in order to ensure they do not lose as many food products. Smaller processors are less able to invest in the infrastructure needed to move less-valuable products because they produce fewer of those products and cannot scale to a size that makes them financially lucrative. Furthermore, because of their smaller size small processors cannot diversify the scope of their products to include items that could incorporate all components of the milk. This was seen in two small cheese processors interviewed for this case study. These cheese processors efficiently produced quality cheese products, but they were unable to use other parts of the milk, such as the whey. They did not have the capacity to introduce new products that could use the whey, although one processor expressed having a long-standing interest in doing so. At the time that the interview was conducted the processors were dumping excess whey down the drain. This is something the small processors did not want to do but explained that they had trouble even giving it away because trucking was a large expensive relative to the value of the whey. Conversely, larger cheese processors produce such large volumes of whey that they can justify setting up infrastructure and product lines that move this less-valuable product to areas where it can be consumed. Four of the six processors interviewed discussed the same large processor in Southern Ontario who had just added a dehydrator to their facility to deal with excess whey and skim milk. Interview subjects explained that by adding this unit the processor would avoid shipping charges associated with disposal of the product as animal
feed and instead they could dry the product to produce items with long self-lives such as protein and milk powders. This issue is important when considering the losses associated with high butterfat demand in the dairy industry.

Raw fluid milk can be processed into multiple different products. In Canada fluid milk accounts for almost 29% of the 344 million kilograms of butterfat quota shipped. The remaining 71% is classified as industrial milk and it is processed into various dairy products such as cream, butter, cheese, yogurt, and ice cream (CDC, 2017a). A key issue associated with industrial milk products is: the requirement for butterfat is proportionally higher than what naturally occurs in raw fluid milk. This means that raw fluid milk with higher butterfat should be more highly valued. This is particularly important as butterfat demand has risen (Currie, 2017).

Additionally, consumption of many high butterfat dairy products has increased in the past decade (Figure 4.8). This may be related to the changes in popular health messaging, where once fat was demonized, sugar has now taken a forefront as the substance more highly correlated with obesity and nutritional diseases (Domonoske, 2016; O’Connor, 2016; Reese A, 2017a, 2017b). In Canada, butter intake is relatively stable but other high butterfat content products like cream, cheese, and yogurt and ice cream are seeing a boost in sales (CDC, 2017a).
Interestingly, consumption levels of fluid milk are decreasing, and this is particularly true for skim milk, which had seen general consumption increase since the 1980s but began to decrease in 2010 (Figure 4.9).
This is problematic because skim milk is a lucrative means to sell the low butterfat components of raw milk. Because butterfat is a such a small percentage of the total volume of milk, increasing demand for butterfat coupled with decreased consumption of skim milk means that there will be a surplus of low-fat milk available. How this surplus is used is an important discussion. In 2015 there was a controversial article published about the dumping of skim milk by the DFO (Mckenna, 2015). Since then some processors have developed increased capacity to dehydrate skim milk and make skim milk powder.

Actually, well, Gay Lea in Guelph is supposed to be putting, or has one [a dehydrator], and I think they're putting in another one. And if I heard right, we are shipping a bunch of milk to Winchester, and I believe that that's what they put in as well, is a dehydrator. Because they upped what they take in a day by quite a bit. (Dairy Truck Driver 1, 2017)
Despite this change there is still the potential for significant waste possible at the processing level when a product does not represent a lucrative economic resource. Skim milk powder is a low value product, with prices since 2007 falling rapidly as demand for butterfat has increased (FAO, 2016). The low salable value of skim milk ($4.32 for a kg of skim milk powder compared to $8.39 for a kg of butter) means that companies may need to operate at a loss to pay for shipping, processing, and labour costs (CDC, 2018b). This is particularly troubling when farmers have the ability to increase the butterfat production on farm by changing herd genetics, nutrition, and/or using different breeds of cows, but they are not necessarily doing this because they are not properly incentivized. These changes cost money and require economic incentives.\footnote{See section 4.5.2 for a more detailed discussion of butterfat quota and economic incentives.}

Failure to incentivize increased butterfat production represents a system failure. Recognizing that butterfat demand has increased while skim milk demand has decreased is a first step, but additional action should be taken to reduce the waste associated with this.

### 4.8.2 Breed Preferences

The ability to avoid losses of low-fat fluid milk at the processor level can begin with changes made on the farm. These changes need to be economically incentivized because they require large capital investments by the farmer. In
theory, the Dairy Farmers of Ontario (DFO) incentivizes increased production of butterfat through their pricing strategy (Table 4.3).

Table 4.3 DFO milk pricing for 12 months

<table>
<thead>
<tr>
<th>Date</th>
<th>Within Butterfat</th>
<th>Within Protein</th>
<th>Within Other Solids</th>
<th>Butterfat Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul-17</td>
<td>$10.67</td>
<td>$7.43</td>
<td>$1.47</td>
<td>$0.05</td>
</tr>
<tr>
<td>Jun-17</td>
<td>$10.51</td>
<td>$7.10</td>
<td>$1.43</td>
<td>$0.03</td>
</tr>
<tr>
<td>May-17</td>
<td>$10.61</td>
<td>$7.18</td>
<td>$1.47</td>
<td>$0.02</td>
</tr>
<tr>
<td>Apr-17</td>
<td>$10.58</td>
<td>$7.62</td>
<td>$1.54</td>
<td>$0.01</td>
</tr>
<tr>
<td>Mar-17</td>
<td>$10.71</td>
<td>$7.45</td>
<td>$1.52</td>
<td>$0.01</td>
</tr>
<tr>
<td>Feb-17</td>
<td>$10.63</td>
<td>$7.71</td>
<td>$1.56</td>
<td>$0.01</td>
</tr>
<tr>
<td>Jan-17</td>
<td>$10.61</td>
<td>$7.30</td>
<td>$1.51</td>
<td>$0.01</td>
</tr>
<tr>
<td>Dec-16</td>
<td>$10.60</td>
<td>$7.96</td>
<td>$1.62</td>
<td>$0.02</td>
</tr>
<tr>
<td>Nov-16</td>
<td>$10.67</td>
<td>$7.50</td>
<td>$1.55</td>
<td>$0.02</td>
</tr>
<tr>
<td>Oct-16</td>
<td>$10.67</td>
<td>$8.01</td>
<td>$1.62</td>
<td>$0.06</td>
</tr>
<tr>
<td>Sep-16</td>
<td>$10.53</td>
<td>$8.17</td>
<td>$1.61</td>
<td>$0.10</td>
</tr>
<tr>
<td>Aug-16</td>
<td>$10.30</td>
<td>$7.29</td>
<td>$1.45</td>
<td>$0.11</td>
</tr>
</tbody>
</table>

Dairy farmers are paid according to the composition of the raw milk components (butterfat, protein and other solids) of their milk. The prices are for a kilogram per component. This information is for your convenience only.

Source: (DFO, 2016a)

In practice though this pricing strategy does not seem to cause a maximization of butterfat production. This may be due to the costs associated with making the changes to increase butterfat. A 2014 study looked at the
feasibility of using Jersey cows in place of Holsteins. This study found that because of increased butterfat production of the Jersey cow (Table 4.4), the Jersey is more economically viable than the Holstein\(^8\) (Currie, 2014; Currie, 2017). Although this study was thorough it was unable to account for farmer breed preferences and the apparent added incentive needed to change tradition and have farmers invest in new infrastructure for the smaller Jersey cow.

Interview subjects contacted for this research noted that there would be infrastructure changes necessary if their herds were switched from Holstein to Jersey. For example, small Jersey cows would not fit well in milking stalls designed for much larger Holsteins. For a visual comparison, Figure 4.10 shows a side-by-side size contrast of a Holstein and Jersey cow. The costs associated with purchasing and setting up a new milking system, that could better accommodate body size differences, is high. A 2012 report suggests that the set-up costs range from $125,000 for a basic 8 stall parlor to $1.4 million for an eight-stall robot parlor (Rodenburg, 2012).

Although farmers may recognize that increased butterfat production is highly useful when consumers are demanding more high fat products, it is hard for them to consider switching their herd in part because of infrastructure challenges but also due to a long history of dealing with Holsteins. Running a dairy farm often crosses multiple generation and this acclimates farmers to one breed. Furthermore, in previous generations overall volume of production has

\(^{8}\) Jersey breed was found to have a return of investment of 5.86% versus 4.98% return on investment for Holsteins (based on 2014 data).
been more valuable than pure butterfat – this meant that Holsteins have a long history of being the breed of preference.

Holsteins can be pushed to produce higher butterfat. A simulation model using milk component pricing models and using herd data from Jerseys and Holsteins in Pennsylvania, analyzed pushing Holsteins to 4.08% milk fat found that the Jerseys produce more gross profit than Holsteins but when feed costs are accounted for total volume of components produced becomes the most important feature meaning Holsteins are more profitable (Bailey et al., 2002). Although this research is in favour of the production capabilities and return on investment of the Holstein, it is fairly old research and performed using American herd data and American milk component pricing models. More investigation into this discussion is warranted, particularly in the Canadian dairy environment.

Importantly, three farmers interviewed for this research described that pushing their Holsteins for higher butterfat is expensive, due to the cost of feed additives required, as well as describing that they did not believe it was good for the cows and caused health issues.

This history of breed domination, the parlor set-up expense, and breed controversy means that most facilities are set up to accommodate the large Holstein body size and it makes switching to Jerseys, with higher butterfat but a smaller body size, difficult. There are other larger breeds of cows with higher average butterfat production that could also be considered but the Jersey cow delivers the highest butterfat percentage of the common domesticated breeds
and is therefore the most appealing for current consumer preferences (Table 4.4).

Source: (Hunt, 2012)

*Figure 4. 10 Holstein cow (left) next to a Jersey cow (right) for a visual size comparison*
Table 4. Characteristics of the most common dairy breeds in Canada

<table>
<thead>
<tr>
<th>Breed</th>
<th>Milk Production (kg/year)</th>
<th>Average Fat (%)</th>
<th>Protein (%)</th>
<th>Average Cow Weight (kg)</th>
<th>Shoulder Height (m)</th>
<th>Proportion of Canadian Dairy Herd in 2015 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein</td>
<td>10257</td>
<td>3.90</td>
<td>3.20</td>
<td>680</td>
<td>1.47</td>
<td>93</td>
</tr>
<tr>
<td>Jersey</td>
<td>6699</td>
<td>5.02</td>
<td>3.80</td>
<td>411</td>
<td>1.27</td>
<td>4</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>8496</td>
<td>4.19</td>
<td>3.49</td>
<td>635</td>
<td>1.40</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Guernsey</td>
<td>6730</td>
<td>4.67</td>
<td>3.40</td>
<td>500</td>
<td>1.37</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Ayrshire</td>
<td>7987</td>
<td>4.13</td>
<td>3.37</td>
<td>500</td>
<td>1.28</td>
<td>3</td>
</tr>
<tr>
<td>Milking Shorthorn</td>
<td>6886</td>
<td>3.94</td>
<td>3.28</td>
<td>590</td>
<td>1.28</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Canadienne</td>
<td>5998</td>
<td>4.32</td>
<td>3.56</td>
<td>470</td>
<td>1.30</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>


Despite these issues that help maintain the Holstein breed dominance, there are some who believe that more attention needs to be paid to the issue of butterfat production. A dairy truck driver who has farmed in the past, and who is often personally responsible for delivering unwanted skim milk, commented that the system could be much more efficient.

I honestly think when it comes to the efficiency, like I said, if you communicate, or you make an incentive that it's butterfat that they want - like, I was of the opinion that whole skim milk thing was a big waste ... be more proactive. Dairy farmers can control butterfat production - not a lot, but we can. So, you can make an incentive, guys will go after a higher butterfat milk producing cows. (Dairy Truck Driver 1, 2017)
This driver suggests that increasing the incentive to produce butterfat will reduce waste because less unwanted or low value skim milk will be generated.

It can be suggested that higher butterfat production is already incentivized through the milk component pricing strategy (Table 4.3) implemented by the DFO and other provincial marketing boards. On paper this pricing strategy clearly suggests that butterfat is more valuable but in practice many farmers are not pushing their cows for increased production of butterfat. Some farmers are, in fact, trying to reduce butterfat production. All but one of the dairy farmers interviewed suggested that there is a balance that needs to be met between butterfat levels and protein levels to obtain the maximal payout which makes them avoid pushing butterfat levels too high. This optimal balance was reported by interviewees to be related to feed costs as well as how total volume produced decreases as butterfat increases and these features are also impacted by changing protein levels.

Other farmers corroborate this by describing that increasing butterfat through adding Jerseys to their herd is an inconsequential consideration.

No, I never [think about Jerseys], I think it's just Holsteins...[they] produce the most amount [volume] of milk. That's economics...you get paid for your proteins and stuff. If you only have a certain amount of butterfat quota ... but you still get paid for your proteins. Sometimes it's good to keep your butterfat lower, so you can ship more proteins...You don't eat up your quota as much, you can ship a lot more milk. (Dairy Farmer 10, 2017)

Despite the current economic pressures that do not necessitate consideration of increasing butterfat, some farmers reported they would be willing to work to increase it if it made sense financially. Dairy Farmer 10 was also quick to add
that “if there were incentives for [increased butterfat]” he would look to accelerate his herd’s production. He ended with the casual comment, “why not, right?” This approach to production is common for dairy farmers. Despite attachments to specific breeds, they can be economically incentivized to alter their production strategies when it is economically reasonable to do so.

In order to more clearly examine the impact of the milk component pricing strategy on butterfat production calculations are done on two typical dairy herds (Table 4.5). One dairy herd is concentrating on butterfat production (farm A) while the other is concentrating on volume production (farm B). Focusing on different components changes overall production in terms of total volume, butterfat, and protein. Farmers interviewed noted that when butterfat is high, overall fluid volume decreases.

The calculations reveal that, when the milk component pricing strategy for Ontario is applied (Table 4.3), both herds end with very similar payouts for one day of production. But when this amount is multiplied by an average number of days of lactation (305) the effect becomes much more pronounced. These calculations show that the component pricing strategy does not do a good job of incentivizing butterfat production and in fact it disincentives it in this example. Factoring in feed costs may be expected to provide some insight into the component pricing strategy but farmers interviewed for this research regularly reported on the added cost of feeds that are required to boost butterfat production.
These calculations, along with farmer interview feedback provide useful evidence that the current milk component pricing strategy is not effectively incentivizing farmers to increase butterfat production.

Table 4. 5 Comparison of payout ($) for dairy herds concentrating on different production factors

<table>
<thead>
<tr>
<th></th>
<th>Farm A</th>
<th>Farm B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total daily production (L)</td>
<td>7157</td>
<td>7700</td>
</tr>
<tr>
<td>Butterfat (%)</td>
<td>4.04</td>
<td>3.85</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>3.58</td>
<td>3.27</td>
</tr>
</tbody>
</table>

Payout for butterfat ($) 10.67
Payout for protein ($) 7.43

Farm A Daily Butterfat
Value ($) \(7157 \times 0.0404 \times 10.67 = 3,085.1536\)

Farm A Daily Protein
Value ($) \(7157 \times 0.0358 \times 7.43 = 1,903.719\)

Daily ($) 4,988.87 Yearly ($) 1,521,606.18

Farm B Daily Butterfat
Value ($) \(7700 \times 0.0385 \times 10.67 = 3,163.1215\)

Farm B Daily Protein
Value ($) \(7700 \times 0.0327 \times 7.43 = 1,870.7997\)

Daily ($) 5,033.92 Yearly ($) 1,535,345.96
Failure to change breed usage in response to changing consumer preferences for milk components represents a system failure. Although dairy breeds could be more effectively managed to provide more butterfat, there is also a system failure in the milk component pricing strategy. Farmers require adequate monetary incentives to make necessary changes, and these monetary incentives could be implemented through adjusting the DFO milk pricing strategy. More detailed analysis of the milk pricing strategy, on farm production, and butterfat demand is needed to begin to address this issue. A statistical comparison of multiple Ontario dairy farm’s production numbers should be analyzed using the component pricing strategy to note the difference. It is worthwhile noting that even if no statistically significant difference is found, the DFO should still consider altering the pricing strategy to make the incentives for higher butterfat more noticeable and/or by concentrating on communicating the value of increasing butterfat yields to farmers.

4.9 The Big Picture: The Bullwhip Effect

Observation of the bullwhip effect and echo was identified at the processing level. One processor suggested that there may be some potential for the existence of the bullwhip effect as outlined in Section 2.2. This processor suggested that it is hard to predict orders from their purchasers and that this difficulty impacted levels of waste in their facility.

The biggest thing we can do to reduce loss is require more lead time from our customers for delivery...at any given time a customer can go from their average order, because we forecast right? So, they can go from their average order of 10 a week and then this week I want
20 ... This happens a lot with our food service customers … So, if one of their customers has a promotion that information doesn’t necessarily flow back to us. (Dairy Processor 3, 2016)

This indicates that communication can be a problem. Processors attempt to keep stock on hand, so they can fill orders when needed quickly and unexpectedly. Ensuring a constant supply prevents customer loss to competitors. Ultimately, one processor interviewed reported that it is cheaper for processors to pay for some wasted product then it is to lose customers. This is supported by research that suggested that supply chain performance was improved and food waste reduced through information sharing in supply chains for fresh products (Kaipia, Dukovska-Popovska, & Loikkanen, 2013). Further research is needed to support or refute this as well as to communicate and work with processors to produce the most efficient system. When the business culture for processors places collecting and maintaining their customer base as one of the highest priorities, it may be difficult to adjust the existing behaviour.

Interestingly, most interview subjects who were asked about the potential existence of waste due to communication issues appeared uncomfortable discussing it. One denied observing the effect while most moved the discussion in another direction without answering the question directly. It is difficult to determine the motivations for this but speculatively it is possible that discussing waste is a sensitive topic for most industry participants and addressing this area of waste in the supply chain is particularly challenging. If companies minimize stock piles kept for unexpected order changes, they minimize waste, but it could also impact their ability to provide a constant stream of product to their...
customers. It is also possible that interview subjects had not observed this issue or that waste is not generated from this effect and the failure to respond to questions around the topic was coincidental or due to a communication breakdown. Without further research this question cannot be clearly addressed but because the bullwhip effect is a well-documented phenomenon in other types of supply chains, the evidence collected here should spur further investigation. The evidence presented here is limited there is at least some suggestion that the bullwhip effect may have an impact on waste.

4.10 Retail Waste

The last step in the supply chain that is considered in this case study is the retail environment. Because milk can be processed into so many different products with different shelf lives it needs to be handled in many different ways at the retail level. In retail stores three factors that impact product loss, beyond the shelf life of individual products, were identified and include;

1. Infrastructure and the ability to maintain the cold chain
2. Staff training and compliance
3. Size of the customer base and the store’s ability to turn over product

Maintaining the cold chain is a key component of waste prevention in many supply chains. It becomes more important with animal-based food products such as dairy. Fluid milk is particularly susceptible to temperature fluctuations and represents a challenge in waste reduction as well as food safety with research indicating that principles of Hazard Analysis and Critical Control Point
(HACCP) should be followed with each step in the supply chain being responsible for cold chain maintenance (Jol et al., 2007).

In some cases, the cold chain can help reduce waste in unexpected ways. Retailer eight reduces their waste of butter by freezing it as soon as it arrives in their store. It is hard to know the energy trade-offs associated between refrigeration and freezing of the butter and it is generally outside the scope of this research but a review of information from a Canadian power company indicates that a typical 20 cubic foot fridge uses 530 kWh of power while a 20 to 22 cubic foot chest freezer uses 750 kWh of power (Emera, 2018). This indicates that there are some energy losses associated with this means of waste reduction and further research is needed to indicate how much energy is lost due to freezing product instead of refrigerating it. For the context of this research the most important indicator is that this retailer reported freezing as a means to help them reduce their production of waste. Freezing allowed them to keep butter for longer and ensure that fresher tasting product is sold to their customers.

A complicating factor with cold chain maintenance is staff training and compliance with the training. Because retail store owners and managers typically hire young, part-time labourers to assist with daily activities, they can have issues incentivizing these workers to be vigilant in their duties.

It happens. Stock gets missed because staff forgets, or don’t pay attention to what they are doing ... would you rather rotate stock or go home a few minutes earlier and just say that you rotated the stock? (Retailer 6, 2016)

Additionally, often busy store managers forget to train new staff in stock rotation or stocking strategies that help reduce waste. Well-meaning staff can
then unwittingly contribute to waste production in the store. Sometimes these issues are noticed and rectified with supplemental training, but it is possible that these issues can be let go when it is low value products that are being lost - after all, the cost of labour is one of the largest expenses for a retail business. Other research corroborates this with a 2011 paper identifying training of staff as one of the seven root management problems that contribute to food waste in a retail setting (Mena, Adenso-Diaz, & Yurt).

Tipping costs are so low that it is cheaper for me to get staff to just put products in the garbage rather than opening packages to remove part of the product that might be good and then repurpose it. (Retailer 6, 2016)

Increasing tipping costs or making repurposing options more accessible and cheaper through groups that recover food for charity might be one way to approach tackling this issue. The tipping fees paid by retailers vary based on contractual agreements and region they are located in. A deep discussion of tipping costs paid by food retailer is likely valuable but outside the scope of this research. For quick reference, the City of Guelph in Ontario charges $80 per metric tonne for mixed waste (City of Guelph, 2018), the Region of Waterloo in Ontario also charges $80 per metric tonne for mixed waste (Region of Waterloo, 2018), and for comparison in Nova Scotia, the province with the lowest waste per capita (Conference Board of Canada, 2018), Halifax’s waste management center charges $115 per metric tonne for mixed waste (HDC, 2018).
Finally, the size of the customer base is a relevant consideration. A larger retail store typically has enough customers shopping there that they are able to use strategies such as reduced pricing or repurposing damaged but still edible products into new, often ready to eat, meal options.

You can reduce waste of some produce by turning it into HMR [home meal replacement]. A head lettuce that has some damage can be trimmed and used for ready to eat salads … an apple with a soft spot can be cut and used for take-away apple slices and caramel. (Retailer 6, 2016)

Although this example provided by a retailer is not specific to dairy products it represents the types of efforts made by retailers to move potential waste products out the door with customers. For dairy products this is done by producing products such as yogurt and berries or making ready-to-eat lunches with cheese bites. These dairy items were pointed out by retailers during site visits, but not necessarily commented on directly during interviews.

Unfortunately, smaller retailers do not have an adequately sized customer base to draw on to repurpose large amounts of products. For example, a small retailer described that their fluid milk, an organic variety with a shorter shelf life, was mainly purchased by regular customers. If one week a customer did not come to make their regular purchase they would have to waste the milk, with a small chance that they would be able to find someone to purchase the milk after it had been marked down.

Interestingly this small retailer’s customer engagement was so high that purchasers of that variety of milk often communicated with the store when they knew they would be away and not able to purchase milk. “They tell us when they
are going on vacation, so we can reduce our ordering and prevent waste” (Retailer 8, 2017). This provides a small example of how a more engaged consumer base can help reduce food waste at the retail level.

Retail waste has elements of both system and technological failures. Despite this, some waste has been addressed, in large part, by technologies that improve shelf life. Although, technical development to improve shelf life would likely not be useful for retailers who provide milk with minimal processing to a discerning customer base. It is difficult to know exactly how many consumers fit in this category, but 2016 data suggests that 27% of consumers say they regularly purchase organic dairy products (OTA, 2017). Furthermore, increasing tipping costs paid by retailers may encourage use of retail staff to repackage and repurpose food items more often.

4.11 Conclusion

Dairy supply chains provide some unique challenges due to the expense associated with producing the milk, and the milk’s vulnerability to degradation, particularly associated with temperature maintenance. Supply management also offers a unique set of issues that impact waste generation. This research identified that waste occurs due to:

- Management issues on farm that produce treated milk that cannot be added to the supply chain.
- The presence of incentive days, which are associated with supply management and attempts to boost butterfat availability.
• Unpredictable consumer demand which makes forecasting difficult.
• Poor communication in the supply chain which can lead to waste.
• The inflexible milk production schedule of the cow making responding quickly to changes in demand difficult.
• The short product shelf lives of dairy creating waste when products are not moved through the supply chain quickly.

These issues are noted in Figure 4.11 which shows the dairy supply chain with the addition of areas where waste was noted in this case study.

Figure 4.11 Dairy supply chain with areas where waste can occur noted
This research described that the current milk component pricing strategy associated with supply management may be causing an increase in wasteage, as butterfat is not properly incentivized relative to high consumer demand for butterfat products and low consumer demand for skim milk products. Supply management, however, may be a more effective means to reduce food waste when compared to the laissez-faire approach in other supply chains due to the ability to exert centralized control over many aspects of the market. Supply management offers a useful system to control waste production through policy changes that impact each level of supply chain. This is unique to supply managed systems and could be seen as a benefit to their implementation. Interestingly, dairy supply management’s recent attempted to reduce waste has come into conflict with the un-controlled markets in the US by introducing a new class of milk that helps keep less desirable skim milk powder in the human food supply chain (see section 4.2).

Finally, a common theme that can be pulled from many elements of the dairy supply chain where excess waste was noted can be related to communication or devaluation of the milk-based products. This is true for waste occurring on the farm related to incentive days as farmers and processors are not communicating effectively which leads to distrust from a perceived lack of transparency. Furthermore, the loss of skim milk can be related to the development of a milk component pricing strategy without effective communication with farmers. This pricing strategy has not caused farmers to value butterfat production over other constitutes, in line with market demand, and
therefore they have not minimized skim milk production. Finally, spoiled product at the retail level could be improved with improved communication between retailers and consumers as well as retailers and processors.

If the dairy supply chain begins to address these issues through improved communication and through a supply chain-wide effort to increase the perceived intrinsic and extrinsic valuation of the product they will move towards becoming a value chain. This move towards a value chain means that the chain embodies the concept of the offering outlined by service dominant logic described in section 2.2.2, which works as a motivating factor to food waste reduction. This approach to dealing with issues of waste identified here can be seen as the foundation on which specific actions to address the specific causes of waste identified here can be formulated.
Chapter 5 – Case Study of Leafy Greens Supply Chain:

Food Waste – Where, How, and Why

5.1 Introduction

The following case study examines the Ontario leafy green sector. It looks at the leafy green supply chain in detail using one-on-one interviews with supply chain participants at all levels as well as through extensive examination of supplementary industry documents. Interview subjects represent conventional and organic handling strategies from large and small organizations. The case is written to look at where waste is occurring at each step in the supply chain, identify causes of waste, and to suggest opportunities to reduce or eliminate waste and improve efficiency.

Specific quantities of wasted leafy greens were not collected as part of this process. The research was designed to be iterative and incremental to develop common themes expressed by supply chain participants that relate to waste generation and efficiency. Furthermore, due to the sensitive nature of the issue of waste, gaining access to numerical data from interview subjects and external sources was difficult. Some supply chain participants did not track that information in detail while others were uncomfortable providing it.

For this case study, members from multiple levels of the Ontario leafy green supply chain were interviewed between November 2016 and August 2017. Eight leafy green farmers, six leafy green processors, six leafy green distributors, two leafy green marketers, and nine leafy green retailers were interviewed for this case study. Several of the supply chain participants interviewed had multiple
roles in the leafy green supply chain and therefore offered insight on multiple issues. For example, some leafy green farmers also process the raw product and therefore can be described as a leafy green farmer and a leafy green processor. For a list of the intersecting roles held by interview participants refer to Table 3.2.

Those interviewed represent large farms and organizations as well as small ones. The subjects also represented a range of production strategies including certified organic, conventional, transitioning from conventional to certified organic, and those using organic production strategies but without an official certification – this will be described as agroecological, as discussed by Dumont and Baret (2017).

Canada’s produce sector in general and leafy green sector in particular, generates relatively limited public debate and controversy. An informal review of news articles published on CBC, Canada’s national public broadcaster, between 2008 and 2017 showed that there were 1550 articles published about leafy greens. When compared to other sectors such as dairy, where 9501 articles were published during the same time period (Appendix 6) it appears that there is less public debate occurring around this sector. While this may create a more pleasant working environment for industry professionals it also means that there are likely fewer commentators and perspectives offered to suggest efficiencies.

Furthermore, because the leafy green industry does not have a governing body impacted by public policy, such as with supply managed systems, there may be less interest and controversy in the functioning of the supply chain. The lack of a public policy-controlled system may be responsible for some of the
difficulty in obtaining general information about the functioning of the industry and where waste is occurring. Therefore, research related to the leafy green supply chain occurs largely through discussing first-hand accounts from industry participants and analysis of limited official industry publications.

Despite the limited data available, leafy greens represent an interesting product to review for research on food waste. Leafy greens have relatively short shelf-lives as well as being highly vulnerable to damage through physical abrasion. Also, Ontario has farmers using multiple production strategies ranging from greenhouse, hothouse, and hydroponic, to traditional outdoor growers (Vyhnak, 2013). In 2006 there was an estimated 704 hectares of spinach alone grown in Ontario but that is expected to have increased due to demand changes and better greenhouse growth methods (Severs, 2006). Statistics Canada indicates that between 2011 and 2015 production has risen by almost 70% and imports have also risen by close to 75% indicating an increased demand for the product (Statistics Canada, 2015; Naeve, 2015). Consumption of other varieties of leafy greens are difficult to estimate due to limited data. But according to an informal survey of news articles spinach, kale, and lettuce appear to be the most popular (Appendix 6).

The products under consideration include; spinach, multiple varieties of lettuce, Swiss chard, arugula, collards, and kale. These products largely move from farm to market unadulterated. Typical processing includes washing and packaging. Some products, such as spinach, are occasionally flash frozen for retail, particularly around holiday seasons where spinach dip, as reported by
Retailers two, five, and six, is made and consumed more frequently. Spinach and kale also are frozen to service the juicing, blending, and cooking market but, in general and according to all retailers interviewed for this research that sold both frozen and fresh leafy greens, frozen leafy greens represent a small fraction of retail sales.

5.2 Leafy Green Production in Canada

Total production of field vegetable crops has only grown marginally in Canada since 2014 but the value of these crops has increased considerably. In particular, Ontario can claim 41% of the $486 million of the farm gate value of all vegetable crops, including field vegetables, greenhouse vegetables, and mushrooms, produced in Canada in 2016. Additionally, in Ontario the farm gate value for lettuce was $4 million in 2016 and $5 million for spinach in 2017 (Statistics Canada, 2018c). Furthermore, lettuce, was the second largest contributor to the farm gate value levels experienced in Ontario. Kale and spinach have also seen increasing production and value (AGR, 2017).

Despite the different varieties of leafy greens available what all these products have in common is their level of vulnerability and shorter shelf-lives. Leafy greens are relatively easy to damage due to fluctuating temperatures, poor humidity control and physical abrasion. This means that they are particularly vulnerable to being wasted. Consumption of some leafy green products, such as kale, are rising which is reflected by Canadian farm land allocated for kale increasing by almost 390% between 2011 and 2016 (Shumsky, 2018). In popular
perception kale appears to be moving from a trend to a staple superfood\(^9\) (Baltazar, 2014; CGstaff, 2017). Classification as a superfood seems to be a moving target. Dietitians generally avoid using the term and definitions espoused by marketers and news publications vary, but generally the term is attributed to foods perceived to be exceptionally beneficial for health. In many ways the perception, influenced by marketing and popular news publications, of kale’s benefits is more important to consumption patterns than the nutritional research information as popular publications expressing the benefits of kale are more likely to have wide spread uptake and effect on purchasing behaviour.

The popular perception of the health benefits of kale and other dark leafy greens seems to be, at least in part, warranted. There is a fairly large body of research evidence indicating the value of consuming dark leafy greens. Generally, Canada’s food guide recommends consuming at least one serving of dark leafy greens each day (Government of Canada, 2007). Specific academic data looking at the health characteristics of various leafy greens indicates that dark leafy greens have higher concentrations of phylloquinone, lutein, nitrate, folate, α-tocopherol, and kaempferol and may help to slow cognitive decline with aging (Morris et al., 2018). Furthermore, cruciferous vegetables such as kale have been found to have indole-3-carbinol and diindolylmethane which are reported to be cancer preventative substrates (Fujioka et al., 2016). Cruciferous vegetables are also a rich source of isothiocyanates, which has epidemiological

\(^9\) Defined by the Oxford English Dictionary as “a nutrient-rich food considered to be especially beneficial for health and well-being.”
data indicating that this compound has chemoprotective properties and protective features against colorectal cancer (Tse & Eslick, 2014).

Spinach has seen an increase in availability since 2012 (Statistics Canada, 2017d) which may be related to the increased demand for spinach associated with its reported health characteristics. Interestingly, the availability of frozen spinach has not changed, while total consumption has increased (Statistics Canada, 2017d). Since 2012 lettuce available for consumption in Canada has decreased (Statistics Canada, 2017d) but it appears that other products like spinach and kale are stealing market share from lettuce. This may be a result of kale and spinach receiving superfood status with popular news and media publication advocating exchanging basic lettuce for these “healthier” leafy green alternatives (Coles, 2013).

Since 2011, the number of new products with an organic label have almost doubled (Statistics Canada, 2017d). Supply chain participants, specifically six retailers and two processors interviewed for this research, describe organic as being particularly important in leafy green products, when compared to other produce. It is unclear exactly why customers prefer organic leafy greens, or are at least perceived to more highly prefer organic leafy greens relative to other food products, but it may have something to do with the organic movement in North America originating in leafy green produce (Nuttall-Smith, 2017). This early
inception would have allowed consumers more time to receive information about the virtues of organic leafy greens which could increase demand.

Additionally, there may be lower barriers to entry for leafy green farmers who wish to produce organic or agroecological products. Leafy greens can be grown relatively quickly and easily but other products such as apples require significant investment per tree in terms of time to grow a productive apple tree as well as the infrastructure required to maintain and harvest the produce. It is difficult to know for sure what drives the higher demand for organic and agroecological leafy greens but one leafy green farmer suggested this is an issue related to availability of supply. He suggested consumers look for more organic and agroecological leafy greens only because more are available.

Supply and demand’s funny in that people don’t necessarily demand something and it’s supplied. It’s that people can only demand what is being supplied… So, in a sense, when our system says … eat garbage. That’s what you get. You eat garbage, right? (Leafy Green Farmer 4, 2017)

This farmer described a sort of “viscous cycle” of consumers purchasing inferior products, which is then perceived as demand, so company produce more inferior products which consumers, having no other better choices continue to purchase reinforcing the false supply and demand pattern. Leafy Green Farmer four expressed that this paradigm was one of the reasons he started his farm – to provide consumers with a better option. He also expressed that he believed consumers had more organic options in the leafy green categories, which is corroborated by data from Statistics Canada indicating that numbers have almost doubled over a period of six years (2017d).
This sentiment, that existing food options are not good in many food categories was common among organic and agroecological farmers with many indicating that they became farmers to provide themselves and other consumers with a better choice to what was currently offered in the food system. But similarly, many (three farmers) suggested that although they aspired to produce many types of products in an organic or agroecological manner when they first began farming, they soon discovered that there were barriers that prevented this. A primary issue discussed is the need to see a return on investment early. This need for financial remuneration prevents some new, inspired farmers from developing farms that produce food from long production cycle crops, such as apples, and encourages the planting of fast-growing crops such as lettuce, kale, and other leafy greens. Furthermore, this issue resulted in some frustration as farmers were not able to produce products they desired, and this impacted the perception of the benefit their operation was having. These findings reflected the findings of Dumont and Baret (2017) who noted some agroecological farmers were frustrated by their inability to have their intended impact on consumers and society.

5.3 The Leafy Green Produce Supply Chain

In Ontario, the Ontario Fruit & Vegetable Growers’ Association (OFVGA) acts as an advocacy and supporting body for produce farmers. Although this body works on behalf of all produce farmers, farmers often join more specialized groups that represent or service them better. Organic producers join alternative
groups such as the Organic Council of Ontario or Ecological Farmers of Ontario that focus on producing organic agriculture information. There are also representative organizations for greenhouse farmers who grow their products in greenhouses or hothouses with the Ontario Greenhouse Vegetable Growers group being the most prominent. These farmers have very different needs and require their own representative body because they are minimally impacted by the seasonal weather effects. Some producers may use resources from the OFVGA as well as multiple other producer groups as their farming strategy straddles many categories. All these bodies work to advocate and represent the interests of Ontario leafy green farmers for general government support and protection from external imports.

The flow of produce and the flow of information from various associations is illustrated in Figure 5.1. This figure depicts the Ontario produce supply chain. The structure is generally consistent for the various types of produce, including leafy greens. Individual farmers, processors, distributors, and retailers might have slight deviations from this structure. Additionally, the roles of supply chain participants are often described as fluid, with some supply chain members acting primarily as farmers but also being responsible for processing, marketing, and transporting their own products. Furthermore, often farmers in this sector produce multiple types of food crops, making their expertise diverse. This diversity is particularly common for Community Supported Agriculture (CSA) farmers. For this research two people who identified themselves as CSA farmers were interviewed. One of the CSA farmers, in addition to regularly growing
spinach, three varieties of kale, lettuce, and collards, also produced a variety of other field vegetables that varied from year to year, as well as eggs and sometimes pork. The other CSA interview subject grew several varieties of kale, several varieties of lettuce, and spinach. In addition, they also grew a variety of fruit plants, including strawberries and blueberries. Despite the range of expertise and interactions, Figure 5.1 represents how the majority of leafy greens move through the supply chain.

Interviews with people at all levels of this supply chain were collected, plus information was gathered from industry websites and publications to create an understanding of where food waste is occurring in the leafy green supply chain and how information is flowing. The following sections describe this supply chain in more detail and where there is potential for waste and inefficiency based on the data collected.
This figure shows the general structure of the leafy green supply chain. The arrows represent the flow of the information and product. Occasionally information and products may flow in the opposite direction to what is indicated but those would be exceptional circumstances. The relationships represented here are typically loose and subject to change. Contracts are not always established or formalized, and relationships seem to be maintained out of convenience as well as trust.
5.4 Farm Waste

The first step in the supply chain is on-farm production. Leafy greens are grown by a variety of producers including small, large, greenhouse and hothouse, field, organic and agroecological, and conventional farmers. Leafy green farming is labour intensive, and four of the eight leafy green farmers interviewed reported that they often employ temporary foreign workers to assist with the busy spring planting, summer season, and early fall harvesting season. In fact, the Agriculture, Forestry, Fishing and Hunting sector employs almost 70% of all temporary foreign workers hired in Canada (Government of Canada, 2017b). Although interview subjects reported that temporary foreign workers are common in leafy green farming it is difficult to know exactly how common they are. We do know that numbers reached all-time highs with 2007 reported as the first year the number of temporary residents entering Canada exceeded the number of new permanent residents (Nakache, 2013). Interestingly, the number of temporary foreign workers employed in Ontario as agricultural workers fluctuated between January 2015 and July 2018 ranging from 21,965 to 20,020 (Government of Canada, 2018d). The Globe and Mail released a document detailing the Canadian companies legally authorized to employ temporary foreign workers. At the time of the creation of the Globe and Mail document, in Ontario there were 8705 companies listed as authorized to hire temporary foreign workers. Unfortunately, it is difficult to determine how many of these businesses represent farming activities or more specifically, leafy green farming activities (Globe Staff, 2018). Regardless, only farm owners or managers were interviewed
for this research. It is likely worth interviewing farm employees including temporary farm workers in future research to gain insight into their roles and how they view the waste that happens on farm.

5.4.1 Farmer Experience

Farmers interviewed had varying levels of experience in terms of years in the business as well as background exposure to the industry. The level of experience appeared to have a marked impact on the amount of waste generated on farm. This is particularly noticeable in leafy green production because, as previously described, new organic farmers are attracted to leafy green production. Anecdotally, it was noted during the interview data collection phase of this research, that new farmers were more likely to respond positively to requests. It is possible that more new farmers were willing to be interviewed and to be more candid about their business than experienced farmers. Experienced farmers with longer family connections to farming often have larger operations and therefore more to lose if unflattering information is associated with their business. Also, newer organic farmers interviewed expressed more optimistic views and opinions about changing the status quo, making them more receptive to participating in research about food waste. For example, Leafy Green Farmer 4, an agroecological farmer who had been farming for over ten years but still considered himself new to the industry because of a lack of family connection to farming described that he started the farm “with a plan to change things” in terms of what food options were available to consumers. He described that he began
farming because he could not find the types of products he wanted to buy, so he decided to start growing them. Despite the chance for a selection bias for interview data from new farmers, the generation of more waste by less experienced farmer seems intuitive and was indicated by interview participants in this research.

Multiple farmers, including organic and agroecological, conventional, large and small, described the understanding that you typically waste more when you are less experienced, but it is best described by an organic farmer who ran a large CSA.

So, when I started here ... I totally over-cropped. I had so much produce because I was hired to run a CSA and we sold out. And you're scared shitless that you're going to not have enough food for people, right? In my upbringing, if you don't have enough food for people, that's the worst sin ... So, I was giving people way more food than what they paid for. And at the end of the day, I was donating food to a service agency, and in the second year they said, "we don't want it anymore, it's too much." Right. Because I was giving them too much food—even the service agency couldn't handle it. And that was part of me learning: What crops do people want to eat? How much will they eat of a given crop, in a given week? So you're not sort of flooding your market and then people feeling like, "Oh, I've got too much food just rotting in my fridge"... So, certainly, that was a learning curve for me. (Leafy Green Farmer 1, 2017)

The observation that more waste can be created by less experienced, newer farmers was corroborated by other members of the supply chain. A produce marketer noted that new farmers often brought new, interesting crops on board that are good for the industry, but these new farmers required time to learn about the industry and the demand for their product before they become efficient. As well, new farmers were described as needing time to fully understand their land and what farming strategies would produce the optimal amount of crop.
Figuring out the market, the demand, but also figuring their land. That's a huge thing – once a farmer gets a plot of land, what really is the best to be grown in this climate and the kind of area that you are in is part of the learning. (Leafy Green Marketer 2, 2017)

Many farmers reiterated this sentiment about when and where they were losing product and how they become more efficient. Farmers commonly expressed sentiments similar to the following comment.

I would say that, at times, we have speculated on what we’re growing. But since we have a better handle on our numbers now, I would say there’s not really much reason aside from just poor management decisions. Yeah. I would say it's mistakes in management, generally [that now contribute to food waste]. (Leafy Green Farmer 4, 2017)

This farmer went on to elaborate and suggested that although they still produce waste on farm, current waste is due to poor management decisions and it is produced in lower quantities when compared to the volumes of waste produced when they first began their operation and were less experienced. This suggestion is reflected in a meta-analysis indicating that experience, measured in time farming and formal education, increased farmer efficiency in terms of products that move out the door (Philips, 1994). Larbi-Apau and Sarpong (2009) also supports that education impacts overall productivity. Although these studies did not consider waste reduction specifically there may be a natural relationship between waste reduction and increased product movement off farm to market.

There is a lack of data in the literature on farmer experience and training associated with food waste on farm. One study comparing post-harvest losses in developed and less-developed countries concluded that in less-developed countries farmer education, in addition to infrastructure improvements, financial incentives and microcredit, technology access, collective marketing, and sharing
of public-private sharing of investment costs and risks, is important to reduce food waste in the form of post-harvest losses (Hodges, Buzby, & Bennet, 2011). The applicability of this research is limited though as it describes findings from a less-developed country. More research is needed to identify the value offered by education in training on waste reduction on farm in the leafy green sector in developed countries such as Canada.

As with any profession, farm management mistakes tend to decrease as experience increases. Farmers interviewed talked about a ten-year experience curve with maximum waste being generated at the beginning of the curve, but by year ten of operation most farmers felt they had achieved a minimal level of food waste (Figure 5.2). This idea of the ten-year experience curve and its association with waste has not been corroborated by quantitative data collection and this type of research would be a worthy area of study. In the meantime, this figure provides a basic depiction of an anecdotally observed pattern described by Leafy Green Farmers one, four, five and seven as well as Leafy Green Marketer two. It should be used mainly as a discussion point and a means to direct further research.

Although the observation of a 10-year experience curve requires additional data to substantiate, the idea of farmer experience being correlated to farm production efficiency can be corroborated in management literature. A 2001 study of cereal crop farmers in Britain found that increasing levels of managerial experience, as well as formal education, correlated with increased farm efficiency and financial returns (Wilson, Hadley, & Asby, 2001). Additional research has
also found, in terms of stochastic frontier analysis, that production output is improved when a farm manager has better decision-making capabilities associated with experience (Trip, Thijssen, Renkema, & Huirne, 2002). This case study contributes to this body of literature and expands on it by suggesting that food waste production is also impacted by the experience level of the farm manager.

Figure 5. 2 Described Relationship Between Number of Years’ Experience Managing a Farm and Waste Production on Farm

Despite the potential for increased waste with newer farmers, there is room to consider the value that fresh perspectives offer to any industry. One newer leafy green farmer who runs a successful business, attributed his success to coming into the venture without any previously held biases that are typically carried by farmers, or anyone with many years’ experience in the same industry.

[We] had a sort of life changing experience and decided we’ve got to do something meaningful and then we started this company [a leafy
green farm]. And I think it’s because we had no experience in the produce business and because we had no preconceived notions … And so, we didn’t learn all the crappy screwed up stuff that normally goes on and just kind of figured out a better system. (Leafy Green Farmer 7, 2017)

For this case study, members of the supply chain who received products from Leafy Green Farmer 7 were spoken to and the farm’s products consistently received higher praise than other producers’ leafy greens. Despite the early period of inefficiency, due to being new farmers, this farm was able to gain experience and efficiency and achieve a production quality that was reported to be beyond many of their competitors. This may be attributable to the new perspective these farm managers brought from their time working in other areas. This is an important and difficult consideration when looking at the influence of farmer experience on food waste generation. To maximize supply chain efficiency and quality, additions of members with diverse backgrounds is important but the learning curve for new members will result in the generation of food waste. To decrease this at the farm level presenting more opportunities for newer farmers to work alongside experienced farmers may be worthwhile. Ziegler (2000) makes a call for formalized mentor programs to assist in transitioning new farmers with no familial ties to farming into being productive producers. Despite this, Niewolny & Lillard (2010) point out that training programs such as mentoring are typically informal and secondary to formal education in college or university settings.

Importantly, the identity of a farmer as “new” or “experienced” was not formalized in this research. Farmers self-identified and were not pushed in
discussion to provide temporal limits on their definition of new and experienced. The information that was collected to define new and experienced farmers is related self-identification with a clear distinction made by farmers who had familial ties to farming. Each farmer who identified themselves, in some manner or another, as new to farming did not have familial ties to farming. Of the leafy green farmers interviewed Leafy Green Farmer one, four, five, and seven described themselves as new farmers and they did not have familial ties to farming and began farming in as adults after a period working in other industries.

5.4.2 Record Keeping

An important element of on-farm waste production is the quality of records kept by farmers. Some of the record keeping done by farmers is a result of what is mandated by supply contracts with distributors and producer groups such as the Canadian Organic Growers, which provides detailed information about management standards including principles of good record keeping (CGSB, 2018b). Of the farms surveyed and farm managers interviewed it appeared that farmers who kept good data, beyond the basics of what was required of them, had less waste and generally had better organized facilities and operations. Importantly, the quality of record keeping could not be scored consistently across all interview participants because not all interview participants felt comfortable discussing their general data and waste data in particular (see limitations in Section 4.11). Instead, interview subjects willing to speak about their records were given a positive score for a discussion that included daily inputs of data,
regularly consulting their data, making management decisions based on their data, and actively seeking out ways to collect more useful data. Interview participants who discussed their data collection but who did not describe these habits where not given a positive score. Additionally, the organizational quality of each facility was evaluated through visual observation that noted cleanliness and general tidiness with a number being assigned from one to ten based on the visual inspection.

It is worth noting that early on in the data collection process it became clear that the personal and sensitive nature of farm business data would make it hard to obtain copies of specific data for analysis. Instead, discussions around the types of records kept and data collection strategies happened during the interview process. Often, supply chain participants would speak very generally about the types of records they kept. This seemed to be the best way to broach the subject of farm records without inhibiting further discussion.

It was common for leafy green farmers to describe minimal record keeping strategies with them tracking only necessary information such as costs and sale prices, but a couple exceptions were noted. There were two farmers that described detailed data tracking on many different levels. These farms tracked many data points including the returns on each of their products as well as detailed all the inputs required for each product. They also described pride in keeping very organized records that were regularly consulted. One of these farmers, an organic leafy green farmer, described their process saying;

We're very serious about record-keeping and about data and making data-based decisions... we were wasting a lot ... whereas now
[because of good record keeping] we're up to the point with our wholesalers, where we're getting pickups five days a week on the farm. So, if we harvest a bit too much by accident and we have to put it in the cooler, it's going to be sold the next day [and not wasted]. (Leafy Green Farmer 5, 2017)

Farmers who appeared to have the organized and tidy operation also spoke in terms of concrete numbers when discussing waste. This was used as evidence that data management was taken seriously, regularly consulted, and used to continually improve operations in terms of efficiency and waste production.

We now lose very little. When we pack kale, or we pack something else, it's very little. And we are always tracking [waste] ... annually, if our shrink is between one and a half and 2%, we're happy. The moment it goes above 2%, we're getting nervous. ... So, we have to manage our shrink because that's product we bought that we could not sell, and we have to pay people to put it somewhere to throw it out or something. It's the most expensive way to get rid of product. (Leafy Green Farmer 5, 2017)

In many ways this discussion aligns with the adage often attributed to Peter Drucker that “if you can't measure it, you can't manage it” (Zak, 2013). The importance of measuring operations on farm is obvious, but it is often missed by farmers caught up in day-to-day operations of the farm coupled with a failure to self-identify as managers. In a study commissioned by the Agri-Food Management Institute of Ontario research identified maintaining key financial indicator data as an important farm management activity, second only to continuous farm manager learning (Siren et al., 2015). Farmers in other studies looking at recording keeping behaviour have noted that they do not use extensive record keeping because they do not think the data is useful to them (Tham-Agyekum, 2010). It is also noted that larger farms are more likely to keep more detailed records (Batte, 2005; Woodburn et al., 1994).
Whatever the cause, accurate records appear to allow for better decision making. Without accurate measurements farm managers will not know where they need to improve, and they will not know the impact of the changes they implement. Importantly, there are also less-tangible elements of a farm manager’s personality that are harder to quantify but offers unexpected value. Different skills and the alternative perspectives brought by farm managers with diverse backgrounds allow for exceptional operational changes that can bring valuable insights and eventual new efficiencies (Ryan, 2014).

5.4.3 Field Waste

An interesting, albeit minor, discussion had with the majority of leafy green farmers (six) indicated that although most of them believed that their waste was low, they did not consider product left on the field to constitute a waste problem. The discussion ranged from considering the product left in field as a soil amender, similar to compost, to also include considering it as a type of “cover crop” (Leafy Green Farmer 3, 2018). These farmers considered product left on the field an economic loss and declined to label it as food waste.

Based on the definition of food waste presented in Section 2.3 this should be considered a form of food waste because the food product, which was intended for human consumption was lost, degraded or consumed by pests (Parfitt, Barthel, & Macnaughton, 2010, p. 3065). This creates a question around the quality of self-reported data that can be collected when different definitions of food waste are in use and should be explored further. It has been discussed in
previous research with multiple attempts being made at creating a unified
definition (OECD, 2016; Papargyropoulou et al., 2014; Parfitt, Barthel, &
Macnaughton, 2010; Smil, 2004; Stuart, 2009).

Importantly, the suggestion that leaving less-desirable product in the field
is currently that most efficient strategy is probably true. If a product cannot be
sold in retail it is likely best that the energy inputs required to harvest, clean,
transport, and package the item are minimized. Furthermore, although no
specific data on using decomposing leafy greens as a type of cover crops was
found, evidence of using cover crops suggests that they can be useful for
preventing soil erosion, pest-suppression, soil and water quality, and nutrient
cycling cropping systems (Knowler & Bradshaw, 2007). More work is needed to
determine what value cut leafy greens left in the field have on production and the
farm ecosystem.

5.5 Processing Waste

The processing sector of leafy green supply chains is where product
moves and is transformed from its fresh, raw state through cooking or freezing,
or it is repackaged before flowing to retail. The processors in leafy green supply
chains performed repackaging activities on the majority of the products they
touched, three of six processors did some freezing of the products, while none
interviewed performed any cooking of leafy greens but alluded to processors who
fulfilled this function.
In this sector it was noted that some leafy greens were wasted before the re-packaging step while other leafy greens were diverted to value added products. Value added products include for example, ready-made salads made by three processors interviewed. Two of the three processors who made ready-made salads were integrally connected to supermarkets through their management structure making it easy to cycle the ready-made salads to retail. The ability to process leafy greens into diverse value-added products provides the opportunity to sort and repurpose imperfect products. Despite this opportunity, a large volume of waste was produced because processing is typically the last handling stop before reaching the consumer in the retail store where appearance standards are high.

Interestingly, although it was expected that more waste would occur on leafy green farms due to the delicate nature of the product, farmers did not express agreement when questioned about this, or they directly refuted it.

Okay, not at our farm [waste is not higher than any other type of produce], or at our warehouse level because we make it fresh. We constantly grow new crops. We constantly make new kale. It's never in our system very long. So, for us, as a farm, on the production level, the product is basically picked on order, so we usually don't carry inventory. (Leafy Green Farmer 5, 2017)

This on-demand, picked to deliver style farming offers leafy green farmers the opportunity to reduce their waste as well as reduce waste at the processing location, due to increased freshness. It may be that there is more waste occurring at the retail end which is not experienced by farmers.

Despite the efficiencies worked out to move fresh leafy greens quickly from farm to processor, the processor often still disposes of a portion of the leafy
green product due to damage. This is where the sensitivity and delicate nature of the leafy greens becomes important. Damage is hard to avoid with many leafy greens and most processors expect that they will need to dispose of a certain percentage of this raw food item.

Obviously, there's trimming that needs to be done on our end when product comes in. So, we bring in raw material from the US and from Canada. And typically, when you get product in, there's some other leaves that need to be trimmed off the products that aren't suitable because they've got either what we call mechanical damage, which is when they got put in the box, the leaves got crushed a little bit. There's a little of that that goes on. So, you've got to trim the head just like you would do at home - get those four or five damaged leaves, they get peeled off, and when you look at our processing waste, at the volumes we process, that's a significant amount of waste. (Leafy Green Processor 1, 2017)

Seven of the farmers interviewed as well as all processors, and one marketer interviewed indicated that the level of trimming needing to be done increases with the distance the product travels. Further distances mean longer transit time, which increases the risk for failure of the controlled atmosphere chain, as well as increasing risk of physical abrasion. Minimizing distances travelled by leafy green products would be one way to decrease the waste the occurs at the processing level of the supply chain. This may be possible in summer months, but for cold climates like the one in Ontario, winter months present a growing problem, unless leafy greens come from local hothouses. Identifying exactly how much trimming of leafy green products is done at different steps of the supply chain and under different circumstances was not part of this research and could be an avenue of useful further research.
5.5.1 Trading Area

An important element to the processing waste discussion and related to the distance traveled by the food products before it reaches the processor, is a discussion of the size of the market. As mentioned, the distance products travel impact waste and supply chain participants recognize this problem.

The longest time for waste, is transportation. Products spend five days on the truck from California to here, three days, four days, basically on a truck. Then it comes here and then it sits in a warehouse, then it goes out [on trucks again], to the stores. (Leafy Green Processor 4, 2017)

Despite this recognition of an intuitive problem, there are reasons for products traveling such distances, seasonal climate and weather patterns. In the leafy green supply chain products move according to purchaser and marketer relationships.

There’s lots of competition, for sure, but there’s definitely old relationships. And that’s really what this entire industry is built on, relationships. … we have companies that we’ve dealt with for 30, 40 years. So, I mean, yeah, the relationships are deep, and they do last. (Leafy Green Marketer 1, 2017)

Although there are many marketers in the supply chain, relationships formed between two parties often last. Furthermore, marketers can travel to trade shows and conferences large distances away from their home base to gain new clients and form lasting relationships. As one leafy green marketer explained, this means that a processor in Houston, Texas may regularly purchase leafy greens from a leafy green marketer based in Ontario and has product coming from Ontario.

It all has to do with who you've got contracts with…people would say to us, “Well, that's dumb that 90% of your stuff gets…sold to the United
States.” “I got a pepper from Mexico in the grocery store and your stuff is going into the US. That’s so dumb.” Well, that marketer needs to find a home for that product. And if [Retailer Q] already had the marketer that they deal with from wherever that they get a good price with, then our marketer has to go and find a chain in the US to sell to. That’s just how it works, right? “Well, why can’t I get your products at the grocery store in town?” Well, because that grocery store is a different brand name than who my marketer sells to. And it’s a pain in the butt for me to pack up my product and take it to the [local] grocery store. It’s not worth my time to do that. So, I sell to a marketer and they sell to the States. People just don’t understand that – you know the inside workings of this. It’s really frustrating for people to not be able to buy our lettuce because they aren’t selling it at the local grocery store. … but that’s just the way it works. (Leafy Green Farmer 6, 2017)

These distances traveled are not uncommon and the industry has come up with technologies, like controlled atmosphere and improved packaging, to help increase the durability of the products during transport. Despite this, interview subjects including Leafy Green Marketers one and two as well as Leafy Green Farmers four, five, six, and seven report that further distances do result in more product damage and loss. Furthermore, volumes of academic work have been dedicated to the discussion of food transportation and the losses associated with travel distances (Gunders, 2012; Hammond et al., 2015; Parfit et al., 2010). Specific data on the waste associated with transportation is typically highly product and packaging type specific. For a baseline, one study on lettuce found that for the strain Ithaca 989 which was vacuum packed, protected from abrasion and light, kept chilled at 6°C, and kept at 80–90% relative humidity, had a visual quality decrease of 50% over 21 days and was expected to decrease more if the product was handled roughly (Schofield et al., 2005). This association between waste and transportation distance represents an opportunity for waste reduction if retailers are willing to establish new relationships with marketers located
geographically closer – this can decrease product travel time and therefore may
decrease waste generation. Importantly, waste elimination through decreased
transportation distance will be limited based on climate factors. If consumption of
temperature sensitive items, such as leafy greens, are desired throughout the
winter season transportation from warmer climates to cooler ones will likely be
required at some point.

The issue of increased waste and transportation times is described in a
2009 paper that discusses the link between overall vehicle effectiveness (OVE)
in relation to wasted products. Although the authors of this case study did not
provide specific numbers on waste reduction, they recommend order
consolidation, lot splitting, and sequencing initiatives so that overall
transportation times can be decreased in order to minimize waste associated
with transportation (Villarreal, Garcia, & Rosas, 2009). Although shorter supply
chains are not directly mentioned in most supply chain research as a tactic to
reduce food waste, it is advocated by an increasing body of sustainability
literature and popular publications that suggest supply chain shortening as a
means to reduce food waste, increase agricultural sustainability, and improve
crop diversity (Aubry & Kebir, 2013; Canfora, 2016; Galli & Brunori, 2013).
Furthermore, reducing waste associated with supply chains can be facilitated, in
part, through a reduction in storage and warehouse times (Hertog et al., 2014).
Again, this is highly product specific and dependent on a large variety of storage
conditions. In general, there is a deficit of specific numerical data on waste
reduction through reduced transportation and more research is needed to
produce this information. This research presents evidence that waste is happening in a specific supply chain – leafy greens – and this evidence merits further research to collect specific numerical data.

Complicating this system is the addition of produce brokers. These parties purchase product and then sell it again as quickly as possible. Regularly these brokers never take physical possession of the product. Because the products they typically have access to are items that could not be sold immediately, the products are often older and have been handled more. It is difficult to find a discussion of this issue in the literature, but it was substantiated by interview subjects including, Leafy Green Farmer five and six, as well as Leafy Green Marketer one and Leafy Green Retailers one and three, who reported that produce coming from brokers has often been in the supply chain longer and therefore can lack freshness when compared to product sold based on an established contract where it moves directly from farm, to processor/packager, to retailer. Complicating this discussion is the vernacular used by various supply chain participants describing products as being “touched by middle men” when referring to broker sales when in actual fact brokers do not typically physically touch the product and are not always men. This phrasing is used to describe that often these products lack freshness due to the time required to reach their final retail destination. Furthermore, some marketers use broker purchases and sales as an opportunity to gain new purchasers and lasting contracts.

How I got a [new] account in...the US - so what had happened was I'd sold produce to a broker. ... So, I figured out that this broker bought product off of me and sold it to this [company]. And when it got to the [company] it was old because it had been touched by a
middle-man and there was issues with it. So as soon as I figured that out I went to the retailer and I said, "listen, essentially you're getting middle-manned." Then at that point then the relationship started to build from there. They're like, "all right, well, why don't you start quoting me." You got to look for opportunities like that. (Leafy Green Marketer 1, 2017)

Marketers seizing these opportunities may establish relationships that are at great geographical distances but despite this, these relationships can reduce some waste by reducing the number of stops that a product must make before it reaches the processor or retailer. In this way, marketers exploiting these situations, can reduce some of the waste inherent in the supply chain.

Additionally, the availability in the market impacts waste generation. Because the supply chain can span such large distances, weather or socio-economic changes happening far away can have an impact on local products. For example, when there is too much rain in California it will cause an increase in prices of produce throughout the supply chain. Conversely, as described by Leafy Green Farmer 5, when California has a particularly good growing season, the market is flooded with cheap product decreasing the price Ontario farmers can get for their product. It is difficult to corroborate this information even though it is likely that this information is tracked. Interview subjects did not provide farm gate pricing data and searches through USDA, Statistics Canada and OFVA databases did not produce the required data making this point difficult to verify externally. Statistics Canada does provide a detailed tracking of the Consumer Price Index (CPI) for various food products, including lettuce that goes back well over a decade (Government of Canada, 2018e) as well as weekly summary reports of commodity prices (AAFC, 2018b). This information is helpful but
because the USDA only provides data on yields from California between 2016 and 2017 (USDA, 2018b) no useful comparison can be made. More research is needed to collect and analyze this data because interview subjects pointed out that changes that impact California production are particularly relevant to them because of the massive volume of California produced leafy greens that enter the market in Ontario.

Sometimes California is tight on supply, and then everybody comes to us, and sometimes California is long on supply - we call it they're long on product, and broccoli changes from five dollars a box to $50 a box within two days. (Leafy Greens Farmer 5, 2017)

When California is “long on supply,” as described by Leafy Green Farmer 5, this means that processors and retailers are pickier with their orders. Interview participants indicated that this can result in more waste of slightly imperfect or less desirable products on farm and in processing.

The idea that supply from other areas impacts waste was further explained by farmers indicating that if they believed no one would buy their product because there was a surplus of cheap product coming from other markets, they would not waste resources on harvesting it or moving it further into the supply chain. Because prices can fluctuate so quickly farmers may have already harvested a product when prices suddenly drop making higher quality product more readily available for purchasers. At this point the less desirable product would be diverted to other streams, left in the field, or sent to compost or landfill sites. Price fluctuation in produce, including leafy greens, can be followed through the CPI or overview reports on Agriculture and Agri-Food Canada’s website. These are a Weekly Summary of Daily Wholesale to Retail Market
Prices. A random selection of dates showed that between December 15 and 22 in 2017 red cabbage went from $20 per case to $44 per case (AAFC, 2018b) which supports the farmer reports of price fluctuation.

5.6 Retail – Shelf Life

The availability of large geographical areas to draw from means that retailers can also be pickier about the appearance of food products they bring in. Farmers and processors recognize this as an issue that contributes to waste, but they also recognize that as a consumer they would rather purchase the more physically appealing product.

If [a large retailer] has a few bugs on their lettuce but down the road has a really nice lettuce with no bugs, right? [The large retailer] could say to people, "they're harmless. It's fine. It's good for the farmers. It's good for everyone. There's no pesticides. It's fine." No one's going to buy it still, right? It does come down to the consumer but it's competition between stores, having nice stuff and- yeah--... Me as a consumer, I don't know, maybe [I'd pick the lettuce from the large retailer] given the choice. I'm probably going to just pick the lettuce without bugs on it, right? (Leafy Green Farmer 6, 2017)

Although this quote represents the consumer perspective of a farmer it provides insight into a well-documented issue. Early studies note consumer preference for attractive produce and although education on how this preference is impacting waste generation is growing, the preference for perfect produce has remained present in more recent investigations (de Hooge et al., 2017; Govindasamy et al., 1997). This problem is a difficult one to address because it is symptomatic of cultural perspectives and beliefs that permeate deeply, even into supply chain participants that are knowledgeable about the products they are purchasing.
It is suggested that markets with different cultural understanding and relationships to food produce less waste. For example, in Europe food is displayed differently in the grocery stores because customers do not place the same standards on the appearance and display of the product.

If I go to Germany and I go in supermarkets, I always walk the produce display. They display it much less artistically. Here [in Canada], everything gets taken out of the box and gets displayed and over there [Europe] a lot of times they just put the whole box in the display and people take it out of the box. So, in supermarkets over there [in Europe] the produce displays have a lot more of a market atmosphere because the consumer can see the box the product is coming in and it doesn't get over handled. … here, the product gets transferred onto a wet counter and so on, where is can be over handled. So, I think that's one thing [that contributes to waste]. Number two, they [Europeans] can put product on a supermarket shelf that here in North America would never sell. People wouldn't take it because it's not so nice. Apples are not so perfect. Oranges are not so perfect. And [Europeans] buy it because there's nothing wrong with it. You can cut a little piece away and the rest is good. Or the skin is not so perfect. Over there, people buy it and it's amazing and I come home or I send an email home to the office and say, "man, take a look at this picture. I wish we could sell product like that."

(Leafy Green Farmer 5, 2017)

This suggestion by one leafy green farmer is supported by research indicating that produce appearance is impacted by produce grades & standards (G&S). Companies had specific appearance targets based on the market they were accessing (Reardon et al., 2001). Therefore, a company targeting a US or Canadian market may enforce different G&S in order to meet the perceived tastes of the customers. Furthermore, the ability to reduce handling, both by staff and by customers at the retail level impacts food waste generation as evidenced by research looking at packaging that can reduce the physical impacts of handling and therefore reduce food waste (Marsh & Bugusu, 2007; Heller et al.,
Changing the conditioning of consumers to search for the lettuce head that is the most beautiful could be a difficult but useful step in waste minimization. Members of the supply chain at all levels are aware of the amount of waste generated by consumers handling.

You go on a Saturday afternoon or Friday afternoon to the store and look at their leafy green counter. It looks like a herd of buffalo ran through it. But that was done by the consumer picking through it, messing it up, not being respectful to the product. (Leafy Green Farmer 5, 2017)

This reported lack of respect for the product seems to be a contributor to waste at the retail level. Further research is needed to determine the extent that consumer handling impacts waste. Furthermore, investigations into the reasons for consumers over handling the food products are needed. It may be symptomatic of the low cost of the product. The association of cheap food with food waste has been suggested previously in the literature (Godfray et al., 2010; Hall, Guo, Dore, & Chow, 2009) and is corroborated by three leafy green farmers, two leafy green processors, and three leafy green retailer interviewed for this research. Interestingly, although the association between cheaper food and waste has been suggested frequently in the literature there is a lack of quantitative data that shows the connection. More research in this area to produce specific numerical data is warranted. Additionally, it is also worth considering further how retailers display and organize their stores and how this impacts waste.

Occasionally products are produced that can reduce waste but consumers appear to be so accustomed to picking products based on the lowest sticker
price that these alternatives are ignored. For example, a live lettuce product with the root attached, was developed by Leafy Green Farmer six. Leafy Green Farmer six reported that this product has a much longer shelf-life in store and in the consumers’ home. This means waste generation would be much lower. The publication *Produce Retailer* also described the 18-day shelf life of the rooted lettuce product as being much longer than traditional packaged lettuce (Riemenschneider, 2017). While Riemenschneider did not comment on the shelf life of traditional packaged lettuce one study suggested that lettuce can last about 12 days when stored at 0°C (Derossi et al., 2016) indicating that the live lettuce product did provide a shelf life advantage. This is further corroborated by research indicating that across all measures of harvest style storage, rooted lettuce had the longest shelf-life (Lin & Hall, 2002). Unfortunately, consumers did not purchase the rooted lettuce product in high enough volumes to make it viable. Instead consumers appeared to prefer bagged and boxed leafy greens that are cheaper at the time of purchase but are susceptible to waste at higher levels due to shorter shelf lives. Cost of leafy green types was determined based interview subject feedback and based on an informal survey of three Southern Ontario grocery stores showing that live lettuce was an average of 53% cheaper than cut lettuce of the same type and quantity (2018).

Research has assessed food waste per household to be occurring at varying levels. A conservative estimate places US household food waste at 25% of all the food brought into the home (Parfitt et al., 2010). This work is not specific to lettuce and more work is needed to determine how much lettuce would need to
be wasted for live lettuce to be worth the extra investment, but this research provides findings that indicate that this work may be warranted. Furthermore, there is some evidence that levels of organic waste for items, like lettuce, with short-self lives are higher in the home (Parizeau et al., 2015). In the UK research has indicated that the level of household waste of lettuce and leafy greens is 50% (Quested, et al., 2011) indicating that there may be more value in producing delicate products with longer shelf-lives, such as rooted lettuce.

The failure of these types of products can be difficult for farmers to understand and may decrease their willingness to spend time and resources to develop waste reduced food items when they cannot find a market for them. The farmer in this example described their changing attitude towards the live lettuce.

But for this stuff [live lettuce], we're like, "Oh, it's going to be awesome. It's going to be so popular because it won't go bad and … it's a really good product that won't be as wasted." But because I think it was kind of different … people really like what they like, and that's what they'll to go back to. So, I think that it was the price point was a little bit higher … So, when it comes down to it, we were sort of coming on the market with something that was kind of new and a little bit different and innovative, but it really didn't take off. And it was a thing that probably could've reduced waste. (Leafy Green Farmer 6, 2017)

Four leafy green retailers and one leafy green marketer suggested that in order to reduce leafy green waste at the retail level consumer preferences and expectations need to shift. Although some evidence for the benefits of this was noted, it is also possible that practices in the retail environment could change in order to reduce waste. These may not have been discussed by retailers interviewed for this research because of a blind spot to potential changes to an industry that they are deeply entrenched in or also possibly due to a fear of being
judged for their actions or inaction on a controversial issue. Whatever the case, a shift in retailer and consumer behaviours that show an increase in the intrinsic value of food items and causes a decrease in handling of the food items has the potential to impact food waste generation. Possible shifts in retailer behaviours that could impact waste include a reevaluation of the mantra of stack em high, watch em fly as anecdotal evidence indicates higher stacks result in bruising and damage of product which results in food waste. Furthermore, evidence suggesting the relationship between sales and display sizes is discussed in a research paper from 1998 that encourages retailers to reduce the number of SKUs by 25% and increase the display size of other product in their stores to improve consumer assortment perception and this in turn is suggested to increase sales (Broniarczyk, Hoyer, & McAlister).

5.7 Conclusion

The data collection for this case study revealed unique leafy green supply chains with unique waste opportunities and challenges. Interesting differences and extra challenges were noted primarily due to the high vulnerability and short shelf life of the product. Specifically, it was noted that waste occurred due to:

- Farmer experience levels with more experienced farmers producing less waste, while new farmers may bring novel and innovative techniques.
- Product cut but left in the field due to damage and appearance standards.
• The quality of record keeping appears to be related to waste generation on farm as farmers who reported more detailed record keeping strategies appeared to waste less.

• Established supply chain relationships impacted waste through the likelihood for these relationships to remain even if farmer and retailer are separated by large distances which causes some product loss due to transport time required.

• Short product shelf-life and vulnerability to damage are inherent features of leafy greens that impact waste but have been mitigated in cases through better packaging, decreased handling and shortening of the supply chain.

Figure 5.3 shows the leafy green supply chain with the addition of the areas where food waste was noted in this case study research.
These features of the leafy green supply chains present an opportunity for additional research and strategic changes to industry and government policy to encourage changes that can lead to waste reduction. For example, establishing support and learning networks between existing established and aspirational farmers before the new farmers begin farming may help reduce the learning curve and associated waste while providing established farmers with new worthwhile approaches. Additional research is needed to further substantiate these findings and support them with quantitative data to better direct action.
Establishing a communication network between existing established and aspirational farmers is one way to increase the communication, transparency, and value input in the leafy green supply chain. This is a necessary function of moving towards becoming a value chain as described in section 2.2.2. This research suggests that becoming a value chain happens when the chain as a whole becomes more interested in communication and adding value to create a better offering. It is also suggested here that this practice is a foundation for food waste reduction as communication has been described to reduce inefficiencies in the supply chain. Furthermore, the increased value placed on the product, or offering, is expected to make waste inherently more difficult. This research provides a basic framework to inform further work and discussion. It provides a means of outlining the discussion using goals of value chain creation to aid in food waste reduction for government and industry policy officials. There is a significant lack of data relative to waste volumes and a hesitancy among supply chain members to talk about the issue. More work is needed into this topic and the evidence presented here provides a jumping off point to direct future research.
Chapter 6 – Case Study of Apple Supply Chain: Food Waste
– Where, How, and Why

6.1 Introduction

The following case study examines the Canadian apple industry in general and the Ontario apple industry specifically. It scrutinizes the apple supply chain in detail in Ontario using one-on-one interviews with supply chain participants at all levels as well as through extensive examination of supplementary industry documents. Interviewees represent large and small organizations as well as conventional and organic production and handling strategies. The case is written to look at where waste is occurring at each step in the supply chain, identify causes of waste and suggest opportunities to reduce or eliminate waste and improve efficiency.

Volumes of wasted apples were not collected as part of this process. The research was designed to be iterative and incremental to develop common themes expressed by supply chain participants that relate to waste generation and efficiency. Furthermore, due to the sensitive nature of the issue of waste, gaining access to tangible data was difficult. Some supply chain participants did not track that information in detail while others were uncomfortable providing it.

Nine apple farmers, two apple marketers, six apple processors, five apple distributors, and twelve apple retailers were interviewed for this case study. Several of the supply chain participants interviewed had multiple roles in the apple supply chain and therefore offered insight on multiple issues. For example, some apple farmers also process the raw apples and therefore can be described
as an apple farmer and an apple processor. For a list of the intersecting roles held by interview participants refer to Table 3.2.

6.2 Apple Production in Canada and Ontario

Apples are a valuable product for the Canadian economy generally and Ontario's economy specifically. In the fruit category, they represent $82 million and are second only to grape production at $85 million in value. They are number one in terms of volume produced at 119 million tons (Statistics Canada, 2018d). Almost 14 thousand acres of land in Ontario are designated as bearing area for apple production (Statistics Canada, 2018d). The province of Ontario is one of the largest producers of apples and apples generated $634 million in economic activity in 2016 and the industry is associated with over 5,000 full-time jobs (JRG, 2017).

Most of the apples in Ontario are grown close to the southern tip, along Lake Ontario, Lake Erie, and Lake Huron. Ontario is the province with the highest production of apples but has recently been tied by Quebec. British Columbia is the third highest producer. Figure 6.1 shows the stores of apples in each of the major apple producing provinces. Because of their high production levels Ontario and Quebec are the clear leaders in store levels. Despite the high levels of production in Ontario, it is a net importer of apples at 88 thousand tons in 2014 with a report from the Ontario Apple Grower’s Association (OAG) suggesting there is room for significant expansion of Ontario apple production (JRG, 2017). The net importer status may be tied with some bad seasons where weather
patterns destroyed large portions of the apple harvest as well as the need to import apples in the late winter months when apple stores become depleted.

Figure 6. 1 Canadian apple stores by province: December 2016-July 2017

The way that farmers grow apples in Ontario is changing. In the past, large apple trees that took over a decade to mature to full fruit bearing productivity, were planted on commercial apple farms (Figure 6.2 and Figure 6.3). These trees can be difficult to harvest because fruit is buried deep within the canopy. The thinner canopy of a high-density orchard tree is easier for pickers to penetrate making harvesting more efficient. Furthermore, these orchards are easier to standardize making mechanization possible with planting equipment,
maintenance equipment, and harvesting equipment (Evans, 2017). Also, in older orchard trees, the thickness of the canopy means that many apples do not have access to even amounts of sunlight, which impacts the quality and colour of the final product.

Today many farmers are considering and actively planting high-density apple orchards that are visually identifiable by the smaller, thinner tree sizes, and a trellis system of poles and wires used to support the smaller trees (Figure 6.4). The advantage of this system is that orchards can be much more productive by beginning to produce fruit much earlier after planting; 7 years for a high-density orchard compared to 10 years for a mid-density orchard (OMAFRA, 2012a). Furthermore, high-density orchards produce fruit of a generally better quality that increases the amount of product that can move to market. For example, research looking at using tall-spindle high-density orchards shows that a 50% increase in saleable product can be achieved (Robinson et al., 2014).

The exact level of productivity of a high-density orchard is dependent on a number of features including how dense the orchard is planted, type of apples grown, environmental pressures, and market factors. A historical definition of a high-density orchard describes any orchard between 150-500 trees per acre, but tree density has increased a great deal since early days in the mid 1970s of high-density and these orchards now can reach over two thousand trees per acres (OMAFRA, 2012a; OMAFRA, 2012b). Although the Ontario Apple Grower’s (OAG) association currently defines high density as 908 trees per acre and medium density as 454 trees per acre other groups define these terms differently
and the definition of high density has become a moving target as orchard
growing techniques and technology develop and evolve (OAG, 2016). This
makes the term “high density” too narrow so instead the descriptor higher-density
apple orchard (HDAO) will be used for this research. In Ontario it was suggested
that most HDAO in Ontario have about one thousand trees per acre (John Cline,
Research Station found that profitability increased consistently with density up to
one thousand trees per acre (Funt et al., 1992) indicating that Ontario growers
with HDAO have an adequate density for maximum profitability. The efficiencies
offered by the HDAO improve the quality of the apple produced and mean they
are more likely to move to market. Compared to 25 years ago when only
approximately 60% of the apples in a medium-density orchard moved to market
as table apples, now up to 90% of the apples in a HDAO move to market as high-
quality table apples (John Cline, Personal Communication, 2018).

Figure 6. 2 Older style orchards with standard trees
Once apples are harvested farmers have several options on how to market their product. Some farmers market directly to the consumer at farmers’ markets or through farm gate sales of pick-your-own apples/u-pick or ready-to-go apples. This represents a small proportion of total sales and although the exact number is hard to know. In Ontario, using a comparison of total production and market production shows that it may be less then 3% (Statistics Canada, 2018d).
Other farmers use apple marketers to negotiate the sales of their product. Some marketing groups are co-ops and farmer owned, with each farmer having a vested interest and voice in the operations of the marketing of the apples. Other apples are sold by more traditionally structured marketing businesses that are sole proprietorships, partnerships, or incorporated. These businesses purchase apples from farmers that have no input or influence on how the marketing business is operated.

The most valuable format to sell an apple is as a raw, table apple. If an apple is not suitable to be sold in this format it will be sold as a processing or juicing apple. The value of these two types of apples are constantly fluctuating and the value of the processing or juicing apple has dropped recently. Specifically, the OAG’s 2017 annual report indicates that on average table apples sold for $0.75/kg, juicing apples sold for $0.02/kg, and processing apples sold for $0.43/kg (OAG, 2017a). Throughout the data collection phase of this study, research participants discussed table apples being approximately five to fifteen times more valuable than processing or juicing apples. The value of the juicing apple seems to be underreported in these accounts, but it may factor in the higher price received for processing apples as well as regional and seasonal differences.

Because of the large difference in value, farmers typically aim to produce ideal table apples and anything that falls short of that standard is considered an economic loss and is used for juicing or processing in an attempt to recoup input costs. It was described by Apple Processor 4 that some farmers in the past
produced apples primarily for the processing and juicing market but with the price of processing apples declining so has the practice of growing juicing only apples. The value of the table apple over juicing and processing apples has helped push the implementation of HDAO. Interview subjects also described that HDAO produce fewer grounders because the trees can be more carefully managed. This was difficult to corroborate with the academic literature but in a conversation with an apple researcher, it was indicated that because the apples coming out of HDAO are higher quality, more apples “packout” because harvesters do not need to screen out as many inferior products leaving them on the ground (John Cline, Personal Communication, 2018). There is limited recent research available on this subject but a reference to better packout volumes was found in a text that describes decreased grounder or dropped fruit, as a result of HDAO, and through the application of ethylene sprays such as “ReTain” which decreases drop rate by up to 20% (Evans, 2017, p. 496). Additionally, a study from 1996 performed a regression analysis on orchards with various systems and indicated that medium to high-density vertical or inclined canopy systems are superior to horizontal or low-density vertical freestanding systems, with low density in this study being noted as less than one thousand trees per acre (Baugher et al.). Furthermore, this 1996 research indicated clearly that the ability of light to penetrate the canopy was the largest indicator of packout efficiency of the orchard systems. Additionally, higher density apple orchards are reported to be more productive earlier which yields a better return on investment by leveraging the concept of net present value possible through earlier harvesting (OMAFRA, 2012).
If HDAO are becoming the standard in apple quality this means many small farmers and processors are being priced out of the market because of the expense involved with setting up a HDAO. This price is variable depending on location, specifications required by the individual farmer, and availability of expertise but one article citing unpublished research found that the high-density trellis orchards could cost almost seven times more than standard orchards (Lehnert, 2010). Direct communication with the OAG produced data from a report that is accessible only to OAG members and it shows that in Ontario in 2016 the cost per acre to plant a medium density orchard was $16,057 and the cost to plant a HDAO was $30,614 (OAG, 2016). Despite this 52% difference in per acre planting costs, when mature the HDAO, could be expected to produce $19,600 per acre while the medium density orchard would only produce $9,000 (OAG, 2016). This does not account for the added income associated with the earlier mature production age of a HDAO (seven years) when compared to a medium density orchard (ten years) (OAG, 2016; OAG, 2017a). It would seem that if farmers can manage the upfront cost their income with increase substantially with HDAO. However, without a high-density orchard it is becoming less economical to sell product. Two apple farmers interviewed, and one apple marketer interviewed reported that it is becoming more common to see older style orchards abandoned because they cannot find lucrative markets for their fruit.

The practice of collecting grounder apples for the processing and juicing market has decreased (JRG, 2017). Typically, apples intended to be raw table
apples that are in some way damaged are allocated to the processing sector instead of having apples collected specifically to be processing apples. On farm, seven apple farmers interviewed indicated that their grounder apples are either picked up or mulched into the soil to discourage the presence of pests.

6.3 Consumer Demand

There are suggestions that consumption of apples has declined or at least stagnated recently (Makki, 2015). Exact numbers for in-home consumption patterns are difficult to find but Statistics Canada tracks the volume of apples available for consumption, per person, and uses estimates to adjust the data for losses. This data indicates that apples and apple products available for consumption are at their lowest point since the mid-1970s (Figure 6.5).
The downward trend in overall apple consumption began in the 1990s and currently shows no signs of abating. Industry professionals are looking for more opportunities to increase apple consumption by promoting the health benefits of apples and through the development of new apple products such as apple chips. Interestingly, the rate of consumption of fresh apple products appears to be fairly consistent while the decrease in apple consumption seems to be coming from processed apples. This decrease may be related to increasing messaging.
around the problems with over consumption of sugar (Freeman et al., 2018). If the major contributor to declining sales is decreased consumption of items perceived to be sugary such as juices and sauces, this may be partially responsible for the decline. Further research is needed to substantiate this as currently there is not readily available data indicating exactly which products are suffering from the most decline in consumption as well as a lack of data to indicate consumers’ opinions on the sugar content of processed apple products and how this impacts their purchase decisions.

6.4 Overview of the Apple Supply Chain

In Ontario, the Ontario Fruit & Vegetable Growers’ Association (OFVGA) acts as an advocacy and supporting body for produce farmers including apple growers and its work impacts many elements of the apple supply chain. Beyond this, the Ontario Apple Growers Association (OAG) is more directly involved with all apple growers who farm more than ten acres. The OAG advocates on behalf of the farmers as well as provides research and access to the government (OAG, 2017b). Although these groups work on behalf of the farmers, farmers can join more specialized groups that represent or service them better. Organic producers join alternative groups such as the Organic Council of Ontario (OCO) or the Ecological Farmers of Ontario (EFAO).

The flow of apples and information from various associations, is illustrated in Figure 6.6. This figure is very similar to other produce supply chains in Ontario with some slight distinctions. In the apple supply chain, field waste is specifically referred to as grounders or drop fruit, and there is a specific, although shrinking,
market for these products. Furthermore, the OFVGA is usurped by the power and influence of the OAG, which is more specialized and valuable to apple farmers. Some goods and information flow in the opposite direction to those indicated but these are exceptions to the rule.

Similar to other produce supply chains, there may be individual deviation for specific situations and apple products flowing from farm to consumer. Additionally, the roles of supply chain participants can be described as fluid, with some supply chain members acting primarily as farmers but also being responsible for processing, marketing and transporting their own products. Figure 6.6 is designed to represent a generic apple supply chain to show how many apples moved from farmer to consumer at the time that this research was conducted.

Interviews with people at all levels of this supply chain were collected, plus information was gathered from industry websites and publications, as well as from government documents, to create an understanding of where food waste was occurring in the apple supply chain and how information is flowing. The following sections describe this supply chain in more detail and where there is potential for waste and inefficiency based on the data collected.
6.5 Farm waste

Apples are a crop that require significant investment in terms of time and labour. The cost of labour required to maintain and harvest an orchard is high, representing 27% of the operation costs for HDAO and 32% of the operation costs for medium density orchards (OAG, 2016). The initial cost associated with mechanization options that can maintain and harvest an orchard can be prohibitive for most farmers (Gallardo and Brady, 2015; Martin, 2017). According to the OAG labour becomes the most expensive cost once an orchard reaches at least 40% of its yielding capacity for HDAO, and 25% of its yielding capacity for medium-density orchards (OAG, 2016). The time required to grow trees to a productive point represents a barrier that improved production systems such as
HDAO attempt to rectify as they yield sooner creating positive net present value (OMAFRA, 2012). Higher density apple orchards reach 100% of their yield potential by year seven, while medium-density orchards reach 100% of their yield potential by year ten representing a three-year space of lost income for medium density orchards (OAG, 2016).

Unlike apples, there are many types of produce that are annual crops, which can be planted and harvested in one season. This means they require fewer resources to maintain while they are not producing saleable product. Apple trees require several seasons to mature after planting before their fruit can be harvested and sold. During this time, farmers ensure the trees are cared for by hydrating them, managing disease, and keeping the area around them clean and free of pest attracting material and competitive weeds. These strategies were reported by eight apple farmers interviewed and are represented in the guidelines published by Ontario Ministry of Food and Rural Affairs (OMAFRA).

OMAFRA advocates for integrated pest management (IPM) which requires using all available tools for pest control including weed management and good record keeping (OMAFRA, 2009). A study that compared different management technique applications showed that soil from IPM plots produced that best soil quality index ratings and productivity compared to conventional and organic production (Glvoer, Reganold and Andrews, 2000). Advice from OMAFRA and findings like this encourage farmers to adhere to IPM management strategies. Once the trees are producing fruit the workload increases with the harvesting
process being labour intensive, as well as additional maintenance activity (Gallardo and Brady, 2015; Martin, 2017; OAG, 2016).

The intensity of the activity required to produce and harvest the fruit can result in waste production on the farm. All apple farmers interviewed reported that hired labour is one of the most expensive investments for them which means a product must guarantee significant enough return to justify investing in labour to move it to market. The following section examines where product may be lost and how cost of labour is related to this loss.

6.5.1 Grounders

On farm grounders are the most consistent form of lost or wasted apples. Grounders are the apples that fall to the ground before harvesters have the chance to pick them from the trees. Traditionally, grounders have been used for the juicing market, but this has begun to change recently. The change is likely a result of the movement to more HDAO, trellis-based systems which improves the efficiency of thinning excess fruit and harvesting the remaining fruit. Research has shown that controlled thinning of fruit improves yield quality in terms of fruit size as well as year-to-year consistency of yields (Sansavini & Grappadelli, 1994) and when not done in HDAO yields can be reduced by up to 30% (Greene, 2002). Despite this change in practice, the issues at the root of the movement away from grounders in the juicing market is difficult to determine definitively. At least one processor suggests that it is the availability of cleaner and more manageable apples at lower prices that is eliminating grounder apples from the
juicing market. No direct data was available to corroborate this. Data from annual reports by the OAG did not show any notable decrease in juicing apple availability in comparison to table or processing apples (Figure 6.7 and Figure 6.8). Despite this, interviewees insisted that there are higher volumes of cleaner apples available meaning processors do not need to spend time and resources cleaning grounder apples before pressing them.

The product is pretty consistent, no matter what. The quality of the apples in the last couple years has definitely gone up … And the price has too. It was very common, grounder fruit. When I started here in the early ’80s and a lot of the orchards we bought from … they’d bring truckloads of stuff and you’d see it dumped in the wash…you’d see grass and leaves and everything going in and then it would have to be sorted out. But it was very common. There’s fewer and fewer [of those] growers [now] … And the stuff we buy from them has all been prewashed … and then the price went up, too. … there was one farm down by Simcoe, the guy he used to literally just go down the aisles with his bobcat with a bucket on and scrape them [the grounders] together and dump them into bins. I remember it well. And there would be mud on them and everything. And then what are we supposed to try and do? Wash it all off? … That’s just what we did. Well not anymore. They [those types of farmers] are not around anymore. So, I guess, the cost of harvesting the apples has increased. (Apple Processor 4, 2017)

Decreasing the number of grounders used for apple juices may decrease processing cost and resource depleting activities such as washing and sorting apples from debris. Unfortunately, this means that potentially useful food product is being left in fields or composted on site. More work is needed to determine the economic loss and environmental costs associated with both options in order to weigh the impacts and to determine which is preferable.
Figure 6. 7 Availability of table, juice, and processing apples between 2010 and 2016 (kg). Data collected from OAG annual reports and translated into kg from lbs (2017, 2016, 2015, 2014, 2013, 2012).

Figure 6. 8 Average grower price for table, juice, and processing apples between 2010 and 2016 ($/kg). Data collected from OAG annual reports and translated into kg from lbs (2017, 2016, 2015, 2014, 2013, 2012).
It is possible that the data in Figure 6.7 and 6.8 does not cover a large enough period of time to reflect the changes in availability of processing apples. Particularly because the earliest mention of HDAO farming techniques found in the literature dates back to 1975 (Heinicke) and likely was being discussed and used under different terminology, and albeit with different qualifications, earlier than 1975. Furthermore, OMAFRA’s documents outlining HDAO farming are dated 2009 indicating that the practice was in use during periods not reflected in this data. This makes price changes as a result of HDAO implementation difficult to identify in Figure 6.7 and 6.8.

Although changes in harvesting style has made it easier for processors to deal with the apples that they receive, allowing them to use fewer resources for cleaning and sorting, HDAO were described by interviewees as a factor that causes grounder apples to go unused. Four apple farmers and one apple marketer reported that even with efficient high-density, trellis system orchards there are still grounder apples produced, albeit at lower levels. Furthermore, because not all orchards have made the large investment to move to a HDAO trellis system there are still farmers growing on standard or medium-density orchards which means there are likely elevated levels of grounders on these farms. The inability to use cheap collection methods, such as the scraping action of a front-end loader, means apple sorting and collection by hand is the only option. Hand collection is an expensive, labour intensive activity for farmer.

It's not sexy. You're walking along on your knees and picking up stuff and throwing it into a bucket and then dumping it into a bin, and bringing it back in. Very intensive. It's like they did it 400 years ago, I'm sure. (Apple Processor 6, 2017)
With most of the grounder apples only being suitable for the much cheaper juicing stream, the investment often does not make sense economically. Data on the return on investment of paying labours to pick up grounders is not available but the OAG has reported that the average cost for labour is $15.40/hour (OAG, 2016). If a price of $0.20/kg is used for grounders (OAG, 2017) then even before factoring in cleaning, packing, and transportation costs, a labourer would need to collect more than 77 kg of grounders per hour to pay cover their wages. A job description for apple harvesters published by Cornell suggest that harvesters should be able to pick approximately 375 kg of apples every hour (DeMarree, 2017). This describes picking conditions, not grounder apple collection but it is likely similar results could be expected for both situations. With this information it appears reasonable that a picker could more than pay for their wage but according to farmers interviewed for this research the prices received for these apples are not high enough to cover wages plus all the added costs associated with cleaning, packing, transporting, and general overhead.

Interestingly, there are also farms in some municipalities of Ontario that describe being legally required to leave grounder apples behind due to regulations suggesting instances of contamination pose too high of a risk when using grounder apples for juicing.

We pick them all up and then we sell them. Usually sell them into the juice industry [but] … I don't know how long that will last because now they're starting to say that juice can only be made with handpicked apples, not with apples that have hit the ground. And that's happened in different areas. It's not here yet, but if it happens here, then that'll be a problem, and then no longer will we be able to recycle. We'll still pick them up because it's a whole mature apple
that's on the ground, and a lot of pests over-winter within the whole mature apple... But it costs as much to pick it up as you get for selling it. So, it's not a revenue source. It's revenue neutral, I guess. You get paid back for your labour of picking it up, but that's it. (Apple Processor 6, 2017)

This idea that selling grounders for consumption is not allowed is likely related to publications by the Canadian Food Inspection Agency (CFIA) that cautions that all apples, excluding grade 1 and 2 peelers, should be handpicked. Importantly, the CFIA notes that “handpicked” is difficult to enforce and suggests that inspectors score apples based on being “bruised or dirty” instead of being handpicked (2011). Interestingly, the United States’ Food and Drug Administration (FDA) takes a harder stance on grounders and discourages use of grounders or “fallen apples” indicating that;

The control of patulin may be established at the receiving step at the processing facility at which time the shipment of apples can be checked to ensure that it originated from a supplier who has provided a guarantee that only apples harvested to exclude fallen fruit were supplied in the shipment. (FDA, 2018, section 4.2).

It appears that some marketers use this information to take a hard stance on apples that look as if they have been collected from the ground. If they refuse to purchase them, apple farmers will not spend the time and money to try to bring them to market. Without the option to sell these grounder apples for processing and consumption many orchards will continue to pick them up to control weeds and pests but the investment into that labour will not garner a net positive income flow for farmers and the collected grounder apples will be composted on farm as waste or for soil amendment.
It seems likely that language within CFIA and FDA regulations that discourages use of grounders is contributing to the shift away from their use. A push to produce juices with all hand-picked apples may be also, at least in part, a marketing strategy coming from retailers and not reflect any real danger because, as one processor put it:

I think it would be a huge waste to eliminate grounders from juice. Not only would it increase the cost of the end product but then there's the waste in the system... the apples are washed before they're ground up and then they're pasteurized after the juice is made. There's zero danger in it. (Apple Processor 6, 2017)

Despite the well-known protective effects of pasteurization, it does not work as a cure-all to destroy all deleterious compounds. Certain substances such as patulin, can survive the heating process and are best controlled for by having a clean input product (Frac, Jeziersja-Tys, & Yaguchi, 2015).

Further confusion seems to exist about who will and will not use grounders. For example, one processor of apples for hard cider suggested that grounders make no differences to their production.

The one good thing about alcohol production [for hard cider] is that it's an aseptic process. So, you're not just picking up dirty apples and crushing them. There is a washing process but you're not going to have a perfectly clean apple at the end of it and that's not that big of a deal because the whole alcohol production process eliminates any pathogens that might make it into the juice. If you're dealing with fresh juice, hell yeah, you better worry because you can get all sorts of crazy things which is why they pasteurize all the juice nowadays. But yeah, alcohol production you don't which is great. (Apple Processor 5, 2017)

Interestingly an apple marketer from a large firm suggested that most hard cider processors do not want grounder apples, which limits the usefulness of these apples.
Like, the craft cider industry, hard cider, they don't want grounders... They would just prefer not to have grounders. I don't know what their rationale is, but they don't want grounders. Now ... when you have grounders, you're going to have more injured fruit. Possibly you're going to have a higher instance of decay in that, so maybe they just don't want to deal with that or maybe that affects how their product ferments. And I mean, I would think the fermentation process would take care of most microbes. So, it wouldn't be a safety problem. But I know that - because we sell fruit to the craft guys, and they don't want anything that's been on the ground. (Apple Marketer 1, 2017)

Conflicting views such as these may lead to inflated levels of wasted product as marketers expect cider makers to not want grounder apples and therefore fail to offer them. This is all in spite of literature that indicates patulin is destroyed during the fermentation process (Gonzalez-Osnaya et al., 2007; Stinson et al., 1975). This may indicate that there is a possibility to reduce waste and provide cider makers with an opportunity to purchase cheaper inputs. Either way, more work and open discussions between marketers and cider makers is needed to address the issue and ensure that both parties act in a way that allows for the most efficient movement of product. Additional interviews are needed with cider makers to determine if the view that they do not want grounder apples is real, perceived, and representative. The one cider maker interviewed as part of this research, Apple Processor 5, expressed no concerns over using grounder apples to make hard cider.

Finally, there is an important consideration on the value grounders can bring to the orchard when they are left behind. Although most farmers pick them up because they believe it helps control pest populations and in accordance with recommendations from OMAFRA (2009), some farmers leave them on the ground either whole or after they have been mulched with a lawn mower or
another similar piece of equipment. Farmers who practice this believe that the apples provide much needed nutrients and put them back into the soil as they decompose. This may be a beneficial practice. In one study of conventional, organic, and integrated apple orchards they found that although yields for each farming type were similar, soil quality, measured based on accommodating water entry and water movement and availability; resisting surface structure degradation; and supporting fruit quality and productivity in the organic and integrated farms was better due to the application of compost and animal manure (Reganold et al., 2001). Some of the nutrients required for supporting fruit quality and productivity that the framers believe are provided by the decomposing apples are ones that they would otherwise have to supplement.

We leave the apples on the ground ... I probably haven’t picked up juice apples for 15 years ... they cost me 3.5 cents per pound to replace the nutrients of that apple to put back in the ground, whereas I’m being paid five to five and half cents per pound for juice apples. I can’t pick them up. It’s impossible. So as the waste things goes, am I really wasting a whole lot? ... Organic matter is the key to growing crops ... [we] need to build the structure of the soil. (Apple Farmer 6, 2017)

Farmers that advocate for this method look at the long-term health of the soil and suggest that leaving grounder apples is superior to adding exogenous fertilizers. The farmers interviewed for this research that advocated for leaving grounder apples in the orchard were from conventional (1), organic (2), and hybrid (1) production strategies. Interestingly, the most enthusiastic defender of mulching grounder apples in the orchard was a conventional apple grower, Apple Farmer six. This farmer also stated that leaving the grounders behind is economically logical. It is difficult to assess the validity of this argument. Compost has been
used as a means to build soil quality for years, and although there is a lack of scientific literature looking specifically at the benefits of decomposing apples on soil quality, substantial amounts of investigations have been done on how various forms of compost impact soil quality (Waldron & Nichols, 2009; Bernal et al., 2017). Deciding how to classify apples left in the farm is difficult as it can still represent waste because the apples, which were grown for human consumption, are not used for this purpose (Parfitt, Barthel, & Sarah Macnaughton, 2010). However, because it can be argued that there will always be some loss of product on farm, the most efficient disposal method may be one the requires the least energy inputs and one that produces some form of value.

Despite the potential value grounders can offer to the soil it is reasonable to suggest that the elimination of the juicing market for grounders represents a significant waste challenge. The suggestion that this fruit is not acceptable for pasteurized juice needs to be questioned and further examined, particularly when it seems that most farmers that do not sell their grounders for juice are still using resources to remove them only to treat them as waste products. Also, discussions with apple marketers and hard cider manufacturers about the quality and safety of hard cider made with grounder apples would be useful for waste reduction.

6.5.2 Picking Efficiency

An important component of farm waste comes from how efficiently pickers can harvest the fruit. There are a variety of means to harvest apples including
hiring seasonal staff, mechanical harvesters, and allowing members of the public to pick their own apples. Four of the apple farmers interviewed and one apple marketer described that mechanical harvesters are typically only used in very large, HDAO where the size of the harvest can justify the large investment in equipment. This information was difficult to verify due to lack of published information on prevalence of different types of harvesting systems in Ontario apple orchards. Despite this, labour is widely recognized as the most expensive and limiting part of apple farming. In the literature, mechanization strategies have been separated into categories such as bulk or selective, which indicate the level of precision with the mechanical harvesting technique (DeKleine et al., 2013; Peterson, 2005) as well as robotic, semi-automatic, and harvest-assist, which describes the required level of human labour (Zhang et al., 2016). Techniques involved in harvesting include the shake and catch (He, 2018), motion planning (Nguyen et al., 2013), vacuums or graspers with optical reading picking (Silwal et al., 2017), and picking platforms (Molenhuis, 2014). Despite all the options described in literature, eight of the farmers interviewed and both apple marketers interviewed described that hired seasonal workers are the most common harvesting tactic used by farmers. Currently, platform picking assistance were described by interview subjects as the most economically accessible picking mechanization option for apple farmers. Seasonal workers are still used in conjunction with the platforms and perform efficiently when correctly trained.

Allowing customers to pick their own apples was reported by interview subjects to be the least efficient, in terms of food waste, but it does save farmers
labour costs as well as generate a small premium on price per pound of apples, as customers are willing to pay for the experience of picking. Farmers report that members of the public that pick their own apples often will casually drop apples on the ground if they think they see a better one close by. This leads to an increase in the amount of product loss due to increased number of grounders.

Confirmation reports were difficult to find but a 2014 article in The Gazette recorded an interview with a farmer from Iowa who described losing thirty to forty percent of his crop due to u-pick customers dropping apples. He described that the problem was the most common issue discussed between u-pick apple farmers at trade shows (Miller, 2014).

Apple farmers with pick-your-own or u-pick orchards have some tactics, such as actively keeping the rows clear, and/or hiring monitors to discourage dropping, to help combat this problem. Even with these tactics it was still suggested that pick-your-own orchards are associated with higher levels of waste.

If a person drops an apple and the row is very clean then they think I know it's there. That's the only apple there. And then they're more inclined to pick it up. So that's a thought that we had... One farm that we talked to said they went from having a hundred bins of deer apples [grounders] before they started sweeping them up to at the end - to when they did, they had two. Right? So, there was a lot less waste. There was a lot more going out as pick your own. ... and the swept-up ones are being sold as deer apples...but it’s quite labour intensive to go through the orchard every morning. (Apple Farmer 9, 2017)

Using creative tactics such as thoroughly cleaning the orchard rows every morning before customers arrive to pick their own apples may be an effective and easy to implement method to reduce waste in that segment of the market.
The impact this will have on total apple waste is difficult to assess without knowing the volume of grounders produced as well as the number of u-pick apple orchards. There is limited data showing the proportions of orchards that are u-pick, but one apple enthusiast publishes a website with a database of apple orchards in Ontario, and it indicates that approximately 34% of Ontario apple orchards have u-pick options (Borrie & Chausse, 2017).

When grounder apples are picked up farmers suggest they most commonly are composted or are sold as “deer apples” to individuals who wish to feed deer and other wildlife, or those who are looking for a cheap apple to feed to horses and other livestock. Although the merits of feeding grounder apples to wildlife and other animals can be debated, this application, according to the definition presented in section 2.3, meets the criteria for food waste because it is a product that was originally intended for human consumption. To maximize system efficiency, working to reduce the numbers of grounders by increasing understanding of the issue, and quantifying the volume of grounders can help lead to the development of strategies that can prevent apples from becoming grounders and waste by diverting them back into the human food supply chain.

6.5.3 Trellis System

Finally, a discussion of how an apple orchard is planted is important for waste consideration. Old apple orchards use larger trees and therefore have lower density (<500 trees/acre) while new orchards work at having smaller trees and higher density production (500-2000+ trees/acre). This allows more
resources to go into fruit production and less into the growth of the tree wood and foliage. The modern trellis system is the current culmination of this thinking. It uses poles and wires to hold the trees and allows the tree to use maximal energy for production of fruit, and not to build sturdy trunks and branches.

We’re growing apples, not the wood. I don’t get paid for growing the tree I get paid for growing the apple ... when you plant a system that captures more sun ... you’re going to produce more product...but the cost has gone unbelievably high. (Apple Farmer 6, 2017)

According to interview subjects, modern trellis systems have value in terms of food waste because they allow more apples to be harvested directly from the tree before they have time to fall and become grounders. It is difficult to find data that reflects this. Most publications speak to the increased productivity of the HDAO and do not specifically focus on the volume of dropped apples. Higher density, trellis orchards can produce more fruit due to higher number of trees per acre as well as the limited thickness of the canopy. The dwarf trellis system trees are thin and short. This allows pickers to access a maximum amount of fruit within the canopy. One apple marketer described that “guys on a newer system, a trellis system of apple-growing apples, would have far less juice than a guy with a freestanding tree” (Apple Marketer 1, 2017). This indicates that more apples can be harvested as table apples and less are likely to go for juice, compost, or be left behind in the orchard.

In addition to facilitating easier harvesting, newer trellis systems allow fruit to ripen more effectively in terms of colour improvement due to increased light exposure (Lancaster & Dougall, 1992). Colour development in apples is an attribute that apple farmers and researchers strive for. In a recently published
textbook, Evans suggested that high colour development is one of the four attributes of a desirable apple with the other attributes being firmness, juiciness, and sugar-acid balance (2017, p. 35). Therefore, HDAO that allow better light exposure may help reduce waste by producing better table apples which are less likely to be used for compost or as animal feed. The ability of sunlight to more efficiently penetrate the tree’s canopy improves the colour of the fruit which improves the overall desirability of the apple’s appearance.

They're [the bigger trees] are just a more wasteful tree … they're bigger and they're wider, so there's more interior fruit that may not be coloured or may not be sized [ideally]. And so, you're going to lose that fruit and that's why everyone’s moving towards the trellises. (Apple Marketer 1, 2017)

One drawback to the trellis system is the cost. A farm operation must be quite large to be able to justify the initial financial outlay. The larger the farm the easier it is to validate based on gross volumes being higher as well as decreased marginal costs.

I think there’s guys trying to figure out the payback, whether they can get, a payback on it. So, most of the work on trellis systems in this area has been done at Cornell University, and they've come up with a system. And I think it's about 1,200 - trees to the acre, where maybe a traditional planting around here would be 135, 136. So, it's quite an increase in density. But they're also saying because of the cost of it - and I’ve seen numbers flying around all over the place. I mean, we’re up from $25,000 to $60,000 an acre to put that kind of system in. You need to have a very good-paying apple in order to recoup that money. (Apple Marketer 1, 2017)

The exact costs for these systems are difficult to externally verify. The cost is dependent on the particulars of the area in which they are being constructed. For example, the type of existing trees and how difficult they will be to remove, the ease of access to the land, local precipitation and need for irrigation to keep the
young trees hydrated until established, type of apple trees to be planted, type of planting soil, and drilling posts into, etc. Most industry experts advise having an experienced installer help you build an accurate quote for a particular farm but for a rough estimate the Ontario Ministry of Agriculture, Food, and Rural Affairs published in a 2012 training module on the subject a suggestion that farmers should count on spending more than $17,000 per acre by the end of the first year (OMAFRA). A more recent internal report from the OAG estimates that between the pre-planting and planting years a HDAO can expect to pay $30,183 per acre while a medium-density orchard can expect to spend $16,057 per acre (2016). Research done by OMAFRA suggests that HDAO reach peak production three years faster than medium density orchards (OAG, 2016) making this initial higher outlay of capital easier to justify as long as resources are available to pay for or finance the construction.

Based on these numbers, although there is potential for a more efficient, less wasteful orchard, apple farmers need to be willing to take on potentially significant financial risk to realize these benefits. Farmers interviewed reported that it does not seem feasible for smaller and medium sized orchards. How these farmers defined orchard size was not discussed but because of the higher initial financial output required farmers must be either wealthy enough to pay for the construction outright or have enough assets in property and equipment to secure a loan for the construction required.
6.6 Processing Waste

The apple is a relatively hardy fruit when handled for processing. If handled and stored properly it can last for many months. Controlled atmosphere (CA) and dynamic controlled atmosphere (DCA) as well as careful packaging to avoid bruises has decreased the amount of product lost. A review paper on apple storage indicates that DCA is a better means to control various physiological disorders that cause apples to be discarded (Mditshwa, Fawole, & Opara, 2018). DCA completely eliminates scald after nine months of storage compared to CA (DeLong et al., 2007), as well as providing a 46% reduction in internal browning in “Bareburn” apples (Lafer, 2007), and DCA as well as CA can be effective means of eliminating the instances of coreflush in apples stored for up to nine months (Mditshwa, Fawole, Opara, 2018), and firmness was better maintained by DCA after 120 days of storage then by CA (Mattheis, Buchanan, and Fellman, 1998).

Packaging also represents a useful innovation that improves product lifespan. Research has found that even simple changes, such as using an MK4 case over an MK6 case, both common cases in the apple industry, causes apple bruising to be decreased by nine to thirteen percent (Fadiji et al., 2016). A potential way packaging contributes to waste in the supply chain may be by eliminating the opportunity for viable, but oddly shaped or sized product from the supply chain due to it not fitting the industry standard cases. Figure 6.9 shows a common case and tray for apples. These trays are standard sizes which means that apples that are too large or irregularly shaped for the moulded cups are not
include. Alternatively, apples that are much smaller than the moulded cups are also not typically used to avoid purchaser resentment and feelings of being shortchanged or consumer avoidance at purchase time.

Figure 6. 9 Case tray for apples showing the standardized sizing for apples (MK4)

6.6.1 Handling

Interview participants reported that few apples are lost to waste due to handling failures in processing and during transport. It was reported that packaging is sufficient to protect the fruit in most cases and when losses do occur, they are due to handling failures such as dropping or gouging with equipment when moving apple containers. Although infrequent, when damage occurs, apples that are bruised or punctured may not be suitable to become table apples, but processors have multiple alternative streams, such as juicing or saucing, to divert them to. Therefore, at the processing stage, an apple that experiences damage represents an economic loss for the processor, but it does not necessarily mean the apple will become food waste. Also, because the economic loss is so substantial, processors work very hard to avoid damaging
their table apples. This is because, as explained in section 6.2, table apples are reported to be worth up to fifteen times more than a juicing or processing apple.

Additionally, loss can occur when apples are shipped long distances, with Fadiji et al. (2016) indicating that longer periods of vibration during transport causes increased bruising of apples. Earlier research noted that apples transported in plastic bins had a 15% increase in the number of exterior bin apples bruised when transport distances increased for 55 to 110km (Timm, Brown, & Armstrong, 1996). Reduction in losses are possible through methods such as air cushioned trucks, which have been shown to reduce drops in apple grades by over 42% on average (Sing & Xu, 1993). While some efforts have been made to decrease losses, all processors interviewed in this research tended to describe losses associated with buying apples from these distances in terms of economics and not in terms of waste generation. It may be a reasonable assertion that large volumes of apples shipped from great distances using scale economies are more energy efficient than small volumes of apples shipped short distances, but this commentary fails to account for the environmental costs associated with food waste generation. The longer it takes a perishable product to travel to its end destination, the more waste that can be generated. One processor explained their perspective saying;

There are dozens of studies to show that it costs less to ship that apple from New Zealand to end up in a store in Toronto than if I went out and picked apples, put them in the back of my pickup truck, drove into Loblaws, delivered them to the back door then they went on the shelf, there was actually less energy consumed in the New Zealand apple than the local apple. (Apple Processor 6, 2017)
While specific studies showing the efficiency of shipping apples from New Zealand compared to a Canadian processor collecting local apples to process and bring to a local retail location were not found it is likely that this processor was more generally referring to research that looks at the efficiencies that can be gained through economies of scale and scope. The literature on the efficiencies that can be gained from scale or scope economies is well established and stretches back to the early in 20th century for economies of scale (Stigler, 1956), and to 1977 for economies of scope (Panzar and Willig, 1977). Work by Ge et al. showed that for a food supply chain in Northeastern USA the fixed costs increased with the scale of the operation while marginal costs decreased with the scale and concluded that a food hub’s average per unit handling cost decreased significantly with the number of units handled (2018). Furthermore, it has been argued that practitioners should not fall into the “local trap” in which local food is presented as most desirable despite products coming from supply chains that benefit from the structures of scaled and scoped economies often being more efficiently produced and delivered (Born & Purcell, 2006). It’s worth noting that efficiency for supply chains are often measured based on monetary considerations which does not necessarily represent the true cost associated with less tangible qualities such as ecosystem degradation, loss of local innovation, and economic resilience as argued by de Roest, Ferrari, and Knickel (2018).
6.6.2 Sizing

To protect apples from bruising and to more easily transport them, processors package table apples in standard sized packages that fit a standard number of apples (Figure 6.9), typically 80 or 88 apples per package. This packaging is useful to prevent bruising and damage on the way to retail, which can lead to waste. Unfortunately, these standard package sizes can also lead to waste because they reduce the market for off-sized apples that do not fit the size requirements for the standard packs. One processor described that using a system that discouraged a variety of sizes of apples decreases the amount of lost product in retail. When retailers, particularly large retailers, demand certain case sizes processors are compelled to meet these demands or lose their business. This is problematic at the processing end when apples that do not meet the desired case size specifications fail to be moved to an alternative stream, such as processing for juice and sauces, and instead are disposed of.

So, you have somebody like [Large Retailer X], for instance, that'll only do one size. Like they want everything in six-pound bags. So, the offsetting for that is low margins on their part. Because they only have one size then they have less shrinkage and then they have low margins. The minute you have more size options, you automatically also have more shrinkage, or loss, at the retail location… Because you have to carry all those different sizes and then this one doesn't sell, or that one, or whatever… If I have three or four options of something rather than just one I'm going to have more loss because you're now giving more options and there's a better chance that the one isn't going to sell… it might decrease waste further up the supply chain [to offer more sizes] but then increase it at the retail store. (Apple Processor 1, 2017)

Interestingly, it is also possible that this system is more efficient in term of food waste generation. It was suggested by Apple Processor 1 that retailers who
provide limited apple size selection have reduced shrink, or food waste. Apples that do not meet the rigid specifications of these retailers are immediately sent for processing. This reduces energy inputs required for cleaning and transporting these oddly sized apples to a retailer where a portion of them is more likely to be waste. When a retailer dictates their apple size requirements based on reducing shrink it may be the best means to ensure that food waste is minimized, and that excess energy is not spent transporting food that is more likely to be wasted. This idea is not substantiated by numerical data but is worth considering in this discussion.

Some processors suggest that allowing a market for imperfects might help reduce waste associated with this issue at the processing end. It enables a market for apples that do not fit into the standard sizes while allowing for continued efficiency at the retail end. The imperfect market may provide non-standard sized apples at lower prices which helps them move quickly enough to avoid some waste.

The imperfects, the way it's been done, I think it's actually - in my opinion, has been a positive thing for food waste. I know not everyone agrees with that, but as I look at it, it has decreased the number of apples available for the processing industry, which has raised the price, the processing industry, which has made it more viable to get everything moving that way. (Apple Processor 1, 2017)

This processor described that allowing some imperfect apples to move to retail in their raw, unprocessed form, which had previously been reserved for perfect table apples only, has allowed business-to-business (b-to-b) selling prices for imperfect apples to increase. This is because a more lucrative market has been created for imperfects, or also known as processing grade apples. A higher b-to-
price for processing grade apples may help convince more farmers to move their processing grade apples, possibly grounders, into the supply chain because they are able to receive a price for them that is profitable.

Despite the potential for a supplementary market for processing grade apples that may help offset the waste that occurs as a result of standardized pack sizing, processors and farmers suggest they need consistency in this market to allow them to make correct and efficient business calculations to avoid unnecessary handling and storage costs for apples that end up not being saleable.

Guys [farmers] all over the place that would put them into CA [controlled atmosphere] storage and store them. And then they would bring out one or two bins when they needed them to pack them. But the cost that they'd get charged for storing them never ever made up for the value that they'd get out of those apples. And they'd always complain that they'd sort them out and they only get half of them that are the right size and then the other half is waste. Plus, they've got all the storage charges on top. And they just said it's not worthwhile doing it anymore and that's why a lot of them just went by the wayside. (Apple Processor 4, 2017)

More consistency in the imperfect apple market would help with this. The inconsistency in b-to-b selling prices that exists might contribute to the feelings reported by some interview subjects that imperfections are a marketing ploy created by retailers to appear more environmentally conscious but are really an insincere effort to reduce waste. If farmers and processors are unable to work in a relatively stable market it decreases their efficiency. The need for stability and a reasonable ability to sell the majority of apples grown needs to be considered when making changes to the supply chain structure and operations.
6.7 The Bullwhip Effect

Potential evidence of the bullwhip effect and echo was noted at the processing and retail level. In the apple supply chain there is a level of frustration reported by several interview subjects that many individuals in large companies are not empowered to make decisions that could reduce waste. Discussion of this issue with interview subjects provided some insight into the potential presence of communication issues.

It's a corporate policy that everything has to go through head office. And at head office, I guess, their reasoning is - somebody in a black tie and a white shirt says if we buy from one supplier our food safety risks go down, our price goes down because we got all the volume... But powers were taken away from the store managers to buy and change orders ... all the cheques come from head office. (Apple Processor 4, 2017)

Retailers also explained that when they are prevented from making decisions that are appropriate to their store, its specific retail environment, and with the particulars of their unique customer base, they encounter waste issues more often because they cannot quickly respond to things that impact the purchasing environment of their store. One retailer described that many customers preferred to purchase produce from a local farm and he was confident that he could move more product if allowed to purchase from the local farmer and sell the products in his store. Retailers also suggested that if they could adjust orders and prices themselves, they would be able to reduce waste by accommodating changes in weather that might increase or decrease the sale of specific items.
When large processors and retailers retain centralized control of most of the decision-making power, individuals working directly with the product in retail are unable to react quickly to changes. This causes a decrease in reaction time and a breakdown in communication, as described by the bullwhip effect and echo discussed in detail in Section 2.6. This may be a factor contributing to waste as retailers are unable to adjust orders quickly to meet changes in demand patterns.

6.8 Retail Waste

There was a perception among supply chain participants interviewed that consumers in the retail setting are responsible for a large proportion of waste generation. According to six apple farmers interviewed, one apple marketer, three apple processors, and three retailers, the retail environment is likely the largest or second largest contributor to wasted apples, behind grounders on the farm. Not only was this idea suggested by retailers but also by two interview subjects who were farmers as well as retailers, operating roadside produce stores for their apples and other products. Despite the support offered by individuals that are intimately in contact with multiple steps in the apple supply chain, more evidence is needed before fully embracing this concept. It is hard to substantiate this claim without further research that collects quantitative data throughout the supply chain as well as qualitative perspectives offered by consumers.

Interestingly, the waste that occurs at the retail level may be arguably considered more important than grounder waste because it has had multiple energy inputs invested into bringing the product to the customer. Customers over
handling the apples in a search for the most perfect apple, as well as over
stacking are described by interview subjects to be contributors to waste at this
level of the supply chain.

6.8.1 Handling

Over handling can contribute to waste generation at the retail level by
customers inadvertently bruising or otherwise damaging the apples when they
search through a large stack of apples. One apple marketer shared a humorous
story about a produce shopper at a colleague’s store.

His office is above the food market, so he can watch the people in
the store. He said he watched this lady come in to buy tomatoes one
day, and finally, he walked down. He walked up to her and said,
"Ma’am, here’s five dollars. Would you go shop at my competitor,
because I can't afford to have you in the store."… [she was]
squeezing too many tomatoes. (Apple Marketer 1, 2017)

Although this story may or may not be embellished it does provide a glimpse into
the concern retailers have over consumer created damage to their products. And
although this example is specific to tomatoes additional discussion with this apple
marketer and other retailers produced similar, but less succinct, examples of
consumers causing apple specific waste through dropping, over handling,
allowing children to play with the fruit before returning it to its home, and
changing their minds about a purchase and leaving product throughout the store.
Despite the relative hardiness of apples, these activities result in damage that
can make the product unsalable and thus wasted. In general, it is unlikely that
most retailers would take the drastic action of asking a customer to shop
elsewhere in order to reduce the waste associated with over-handling but this
story does clearly communicate some apparent friction in this area of the supply chain. Research has identified that bruising of ambient temperature foods due to customer or staff mis-handling in retail is one of the seven main causes of waste (Mena, Adenso-Diaz, & Yurt, 2011).

Because this research focused on members of the supply chain and excluded interviewing consumers it needs to be considered that consumer opinions and stories are not available to defend their actions in the retail environment. Furthermore, there may be an element of buck-passing, where responsibility is shifted to consumers as consumers are an easy target to place blame on and this removes responsibility from retailers and other supply chain member. It is possible that actions from retailers could help reduce food waste at the retail end. In general, more research is needed to determine the true relationship in a retail environment between the consumer, retailer, and food waste generation. In the meantime, increasing efforts to inform consumers of the damage and waste caused by over handling may be one way to reduce the loss at this level.

An alternative approach to reduce handling loss, that was outlined by one interview subject, may be to change the way that the product is presented. In many European countries and cities, presentation of produce is managed much differently. Produce is left in the boxes that it was delivered to the store in. This makes it difficult for customers to dig through the product and it reduces handling damage by staff because staff are not handling individual products to place it on
the display shelves. This is likely to reduce damage and food waste and also reduces retailer labour costs.

There is certainly less handling [in the UK]. And I think the store would have less waste if they did that. When we sold into the UK pretty heavily, they used to take - a standard 40-pound box of fruit in five layers. There's five trays with apples on it. They put those on the shelf and always did. …. They don't give them [the customers] the option [to dig through]. (Apple Marketer 1, 2017)

Designing retail space being cognizant of how simple changes may impact food waste may represent a means to reduce waste without implementing expensive and sometimes ineffective consumer education campaigns. This example provides a simple strategy that may be a solution to part of the problem that creates excess apple waste at the retail level.

6.8.2 Perfection

Waste associated with the search for the most perfect in appearance apple is related to handling waste. When customers sort through products searching for the best apples, they are more likely to damage them decreasing the chances these apples will be sold. Furthermore, customer preference for ideal products puts pressure further up the supply chain to only deliver the ideal looking table apple. This results in increased waste further up the supply chain as imperfect but edible products are actively removed at every step of the system.

Retail locations suggest that picking though loose apples increases waste as customers search for apples with the ideal appearance and leave behind less than ideal ones. Despite this, some retail locations have devised strategies to
deal with the apples left behind by adding the less-than-perfect leftovers to their processing activities.

So, you can either get a five-pound bag that we have sorted and then bagged, or we sort them as well and then we just put them in bushels, sort of, on these display bins, and then people can choose them. But if they only want a few, they can choose whichever apples that they want. So, I think people have that choice, and I think having that choice really minimizes on the comments that we get…and then we can make cider out of what’s left. (Retailer 1, 2017)

Finding an alternative market for less-than perfect apples is an effective way to divert potential waste and is made possible by the relative hardiness of the apple. Although not all retail locations have the infrastructure to press leftover apples into juices or ciders, many retailers are exploring the home-meal-replacement market. These ready to eat meals provide a useful opportunity for retailers to repurpose edible but imperfect food into a different format that can be sold for a profit. This option represents one possible solution that can reduce waste generation at the retail level. While this may provide a use for imperfect apples a more fulsome solution may require that retailers include education opportunities for consumers while offering imperfect product for sale at reduced prices. Additional research is needed to describe the most effective means of reducing the loss of imperfect apples in retail locations.

6.9 Conclusion

In general, apples are wasted in relatively small quantities due to the capacity to transform flawed fruit into multiple products. The majority of waste in the apple supply chain seems to be occurring on farm in the form of grounders,
particularly with the market shifting away from use of grounders for juicing and processing. This shift away from the use of grounders requires further reflection and study and possibly a concerted effort to educate supply chain members on the value and safety of grounder fruit, when processed correctly.

The data collected for this case study revealed a unique supply chain with unique waste opportunities and challenges. Interestingly differences and extra challenges were noted primarily due to changing markets for grounder apples. Specifically, it was noted that waste occurred due to:

- Grounders left behind on farm, due to the cost associated with collection and the low cost received at market. Importantly, although the grounders account for waste, their levels may be declining with the rise in higher-density trellis-based orchards that facilitate cleaner and more efficient harvesting.

- Sizing requirements for case sizes excluding apples that do not fit allocated space pre-prescribed trays. When the excluded apples are not diverted to alternative stream for processing, they can become waste.

- Handling damage in retail produces waste through bruising and abrasion. Although retailers suggest consumers are primarily to blame it may take a combination of consumer education and reorganization of the retail environment to decrease this waste of high-input apples in the supply chain.
Demand for perfection impacts waste generation throughout the supply chain as each member expects that only perfect apples are acceptable to the consumer and therefore dispose of the less desirable ones along the way.

Lack of consumer education as well as a need to convince supply chain participants to provide consumers with the opportunity to purchase imperfect apples.

Figure 6.10 provides a depiction of the apple supply chain with the addition of the areas where food waste was noted in this case study research.

![Apple supply chain with areas where food waste occurs highlighted](image-url)
In order to build further on these noted points for apple waste there needs to be additional data collected to specifically direct action. Generally, industry policy makers should work to change wording of industry documents that causes waste, such as through eliminating grounders from contention for juice making or encouraging their use to make hard cider. These changes to policy can extend to appearance standards, which have the ability to create a ripple effect that can impact apple waste across the supply chain and potentially include waste generated by consumers. More generally, a movement that includes consideration of the transparent and easy flow of communication through the supply chain, as well as the consideration of the product in terms of an offering, as described in section 2.2.2, could create a value chain environment which would increase the value placed on the offering moving through the chain. Pushing for a value chain perspective is encouraged for government and industry policy makers as it may act as a framework for increased valuation of the apples moving through the value chain and help result in a decrease in food waste production.
Chapter 7 – Synthesis of Findings for Case Studies and Discussion

7.1 Introduction

This chapter focuses on cross-case comparison, looking for commonalities in the data collected across the leafy green, apple, and dairy supply chains. It also presents the key hypotheses generated in this research and suggests how these hypotheses from each of the case studies are linked and how their connectivity may provide useful learning for other supply chains to reduce food waste, decrease costs, and improve efficiency. In addition to a presentation of the hypotheses, new perspectives and lessons are described by viewing the data together as a unit instead of as individual case studies. Quotes taken from each supply chain as well as data from external sources are used to as evidence to support the themes developed.

7.2 Learning Curve: Waste on Farm

A common issue of inefficiencies and waste was noted when supply chain participants are new to their role. This was noted mainly at the farm level and primarily in the apple supply chain and leafy green supply chain.

So, there are new people who are coming on board, and in the beginning, it is just inevitable. You are not going to be as efficient. You're going to see a bit more waste because it's a learning curve, right? (Apple Farmer 5, 2017)

Figuring out the market, the demand, but also figuring their land. That's a huge thing – once a farmer gets a plot of land, what really is the best to be grown in this climate and the kind of area that you are in is part of the learning. (Leafy Green Marketer 2, 2017)
Although this observation was repeated multiple times by produce supply chain members it was not directly noted for dairy supply chain participants. It is possible that this is not an issue for dairy farmers, but it is more likely that other factors are preventing the observation that the learning curve for new farmers is associated with waste.

One factor that might help disguise this in dairy involves the very high start-up costs associated with dairy farming due to purchasing quota and building complicated infrastructure. Because of these costs, farmers are more often from multigenerational dairy farming families where quota and infrastructure are passed down. In Ontario, between 2011 and 2016, 65 to 68% of farmers passed their quota down to another family member (DFO, 2016b). Statistics on how common it is to have farms passed to the next generation for leafy greens and apple farms were not available. More research into this would be useful. Either way, when farms are passed to the next generation, this means that new farmers have grown-up immersed in learning about how to operate the farm, and often experienced an over-lapping transition when the farm was passed from one generation to the next. This would decrease the losses associated with being a new, inexperienced and less efficient farmer once these people are primarily responsible for their own farm’s operations.

This suggestion is difficult to substantiate because data on the number of farmers in different sectors that grew up farming is not widely available in Canada and Ontario. Despite this, the content of the interviews collected for this
The idea that more experience is related to increased efficiency is not a new concept (Trip et al., 2002; Wilson et al., 2001) and the extension from efficiency to food waste is an easy jump. Further data is needed to conclusively support this assertion and further analysis is needed to suggest means to reduce the food waste impact of new and inexperienced supply chain participants coming on board.

### 7.3 Cost and Availability of Labour: Waste on Farm

Labour costs appear to be another factor that influences waste generation on farm. The data collected for the case studies on dairy, leafy greens, and apple

<table>
<thead>
<tr>
<th>Type of Farm</th>
<th>Number of Farmers Who Discussed Farm Family Heritage</th>
<th>Number of Multigenerational Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Leafy Greens</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Apples</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 7.1 Number of Farmers Interviewed Who Grew-up on a Farm of the Same Type
supply chains indicate that one common theme that emerged is that farmers are more concerned, relative to other supply chain participants, about the cost and availability of labour required to harvest their products. This becomes important for waste generation because when a farmer cannot financially justify hiring additional labour product can be left unharvested and therefore is wasted.

So, I'm imagining that's going to change that calculation to where you say, "is it worth spending the labour to pick a crop that maybe there's an abundance of on the market as it is?" So, you might be more inclined to leave it because it's just not going to be worth it. (Leafy Green Farmer 5, 2017)

The waste generation associated with labour costs changes as the price farmers are paid for their products fluctuate and as minimum hourly wages change. An additional complicating factor in this discussion is the flexible stipulation around paying agricultural workers in Ontario. Specifically, regulation 285 section 2, subsection 2 of the employment standard act allows for agricultural workers involved in the primary production of various food products to be exempt from minimum wage requirements, and allows for pay deduction for living accommodations, if appropriate (ESA, 2018). Although many farmers interviewed suggested that they pay at least minimum wage, the presence of this act provides some flexibility for employers. This policy has experienced some debate between human rights advocates and farmers and has caused concern among farmers that increasing or setting minimum wages for farm workers would severely harm the financial stability of their businesses (Dick, 2018; Ross, 2018).

Furthermore, individuals willing to work the physically demanding jobs are in short supply. This is particularly true when farm managers can only afford to
pay a minimum hourly wage. Many employees can find more comfortable, less physically demanding jobs for minimum hourly wage.

We’ve always paid them more then minimum wage because it is so hard to find labour and it’s a really hard job. They [employees] could go stand at a movie theater or a grocery store and not shovel shit for six hours a day. It’s very physically demanding, and a lot of people don’t want to do it. We’ve always paid higher then minimum wage ... We want to pay our employees well because we want to keep them.

(Dairy Farmer 1, 2017)

Interestingly, the issue of waste, labour availability and labour cost appears to be more closely related to the produce sector. Although dairy farmers commented on the cost and availability of good quality labour, none suggested that labour shortages prevented them from moving the maximum amount of milk possible out the door.

This may be associated with multiple factors. First, as discussed in the previous section, dairy farms often involve multiple generations and many family members. This means that there are more related individuals, with a financial and often emotional stake in the productivity of the farm. Farmers can lean on these additional resources in times of labour shortages.

Second, dairy is a more expensive product and farmers receive more per kilogram then many produce farmers do for most of their products (Figure 7.2). This provides added incentive to move the product out the door and makes the financial calculation that compares the cost of additional labour to the cost you can get for the end product, skew in the direction of moving the product to market.
Finally, dairy, when compared to apples and leafy greens, has a fairly even level of production all year round (Section 4.6.2) meaning staff can be hired and given predictable work schedules and year-round employment. This may make it easier to find and keep well trained staff.

Note: The figure represents the estimated value a farm can receive for an output of work by a single person in one day. These numbers are extrapolated from estimates provided by interview subjects for the dairy, apple, and leafy green case studies. The numbers are based on the use of automation in dairy farming and manual harvesting with limited mechanical intervention in apple and leafy green harvesting because these are the most common occurrences encountered during data collection for these case studies. The data used to generate these numbers is not randomly generated, or a large enough sample size to be statistically significant.

*Figure 7. 2 Estimated Farm Gate Value Possible for Labour from a Single Worker*

Finally, while dairy farming is labour intensive, it can be argued that it is less labour intensive than many other forms of farming. The process of getting the milk from the cow to the tank, and then from the tank to market is largely
automated so it can be moved to market in a less intensive way then some forms of produce. Technological advances have produced equipment, such as rotating parlours and robot milkers, that decrease the labour required to get milk from the cows. Dairy farmer 2 described that she could milk her 650 cows alone each day, obtaining approximately 20,000 kg of milk, along with the assistance of her milking parlour equipment. Although it is impossible to compare different food products directly it would be unlikely for a produce farmer to obtain 20,000 kg of saleable product in one day from the labour of a single individual. Furthermore, robot milkers, although expensive, once installed have eliminated the need for humans to be present during milk harvesting which further decreases labour requirements. Therefore, the robot milkers have a high fixed cost and low variable cost. Typically, mechanical harvesters available for the produce sectors are so expensive only the largest operations can afford to purchase them. Also, often the technology is not sophisticated enough to avoid causing undue damage to the produce during harvesting, which makes them less valuable.

In summary, cost and availability of labour has a large impact on waste generation, particularly at the farm level where the product collection is more labour intensive. For the supply chains evaluated by this research, it was noted that the less labour intensive the farming method, the less associated with waste labour availability is likely to be. As a result, the higher value farm gate products, specifically dairy, is less likely to be implicated with waste due to labour shortages. Further research is needed to determine if this trend holds for other agricultural products as well.
7.4 Standardization of Product: Waste on Farm and in Processing

Standardization is a difficult problem when dealing with raw goods. Having products that are consistent shapes and sizes allows companies to more easily streamline product movement and processing, but natural products are often not standard shapes and sizes. In food supply chains advances in agricultural science have helped with this issue by selecting for plants and animals that are more homogenous and with desirable traits. Despite this there is always room for genetic and environmental associated variability within living organisms.

When differences occur that are not within a defined tolerance limit this often translates into waste. It is often cheaper and easier for a company to dispose of the products that do not fit the desired specifications then it is to set up alternative avenues for these products.

That's a logistical nightmare because if you're on a line that packs carrots into two-pound bags all of sudden you can put four items in one bag and that looks not so great. It's more of a pain in the ass and a headache than anything because you can't use machines to do it [when the carrots don't meet the size specifications]. It's all hand packed. It helps nobody. It makes more sense to throw the product away and use good product...you still have manual packing on the labor end, so it raises costs because it involves a lot of labor...while everything else can run automated. (Leafy Green Processor 4, 2017)

Some recent initiatives have been attempting to tackle the waste generated by the desire for standard, uniform or perfect produce. In Canada, Loblaw's *Naturally Imperfect* line is one of the most well know strategies aimed at reducing waste associated with high specification standards. This initiative focuses on produce that is excluded from sale because it is deemed unattractive. The
Loblaw’s initiative has set-up an alternative stream for traditionally undesirable products and some processors suggest this is helping reduce food waste while other processors say it is doing little to reduce waste and is just a “marketing ploy” (Leafy Green Processor 4, 2017). Whether the Naturally Imperfect initiative is making any real changes in the supply chains is debatable but it is helping increase public awareness of the issue (Kozicka, 2015; Liu, 2016; Press, 2016) which may increase demand and therefore provide more avenues of sale for non-standard and imperfect products.

Dairy presents a unique standardization challenge when compared to produce. Because milk is pooled and heat-treated before sale, waste associated with milk because one farm has a different composition compared to milk from another farm is not an issue. Instead, the inability to standardize and control the composition of milk along with the inability to smooth out the demand curve for fluid milk and dairy products represents a unique standardization problem.

There’s a target [for butterfat and protein] that all the farmers try to meet. ...[Demand patterns] are both seasonal and also during the week. What happens is that the whole [relationship] between the fluid milk and the industrial milk ... so all the fluid guys, if you look at the orders that are placed during the week...the demand on the fluid side is high and then is drops off, so the industrial guys don’t have any milk available for them at the beginning of the week and then we want the cheese guys to take it at the end of the week. So, when the [fluid] guys don’t want it anymore we’re shoving it down the throats of the other guys and they only have two or three days for them to take their whole quota. They don’t like it...If you can get everybody to take fluid milk seven days a week, approximately equal amounts that would help, because then you can actually produce for the whole week ... if you could smooth out the demand that would be good. The other thing is that there are seasonal requirements. So, for fluid milk mostly driven by the school year, because all the schools are pushing milk, when you don’t need it anymore after school all of a sudden demand for fluid milk drops. What do you do with all that extra milk? You’re
giving it to all the extra guys that can take it. So, quota is basically meaningless, when we’re surplus milk that quota at those industrial plants … we’ll give you as much as you want. But [that can be a problem]. So, there was a string of about a year and a half where we were surplus milk and these guys were taking a 100% more milk then their quota. So, if they were taking a million a week they were taking two million. And then they built markets based on that and then we turned short again, then they implemented that ingredient strategy, so everybody started to use Canadian milk again, instead of importing stuff, and all of a sudden, we’re short. Now we have these guys going, “you can’t short me” “I have this whole market I’ve built up over the last year and a half.” (Dairy Farmers of Ontario Representative 1, 2017)

The milk marketing board works hard to make adjustments to their pricing and distribution strategies to accommodate for natural production surges and demand surges, but it is a complicated issue. Furthermore, getting a cow pregnant and ready to produce milk takes time and makes it more difficult for farmers to respond quickly to changes in demand, particularly when a cow’s milk cycle (approximately 10 months) can lost longer then a surge in demand. The lack of flexibility available in the system means that product can be wasted when demand drops off after production had been scaled up to meet the demands of a particular season, for example Christmas. At this point waste is difficult to avoid because of the limited shelf-life of milk. Some milk can be turned into butter and frozen for an indefinite amount of time but already made and packaged products like sour cream, cream cheese, cream, and fluid milk have shorter shelf-lives and are more likely to be wasted at the processor and retail levels.

The ability to standardize production and manufacture products to meet a steady demand are important elements to avoiding waste and inefficiency. The complication associated with biological products makes this difficult and often
results in waste production. If companies are able to increase communication throughout the supply chain and allow for the generation of alternative streams, such as donations and deep discounting, they may be able to reduce the waste associated with inability to standardize and control fluctuations as a result of biological production.

7.5 Economies of Scope and Scale: Waste in Processing

An economy of scale arises from the cost advantage gained from the relationship between increased production of a single product and the corresponding decrease in per-unit fixed production costs. As production of the good increases the costs of production are spread out over more goods, which increases profit. Alternatively, the theory of economies of scope focuses on increased production of varying types of products and the cost advantage that is incurred as a result. Economies of scope emphasizes better using assets and resources so that the costs may be spread over a greater number of units decreasing overall costs. Economies of scope encourage centralizing multiple business functions for increased efficiency and decreased costs.

These theories are important when considering waste generation in different supply chains. Waste can accumulate in the processing sector for businesses that are not able to take advantage of these economic principles. For example, in the dairy supply chain small cheese manufactures produce whey as a byproduct (Figure 7.3). Because the whey components represent a limited financial value and small cheese manufactures produce relatively small amounts
it is difficult for them to justify the spending required to transform the whey into something saleable. Because of this it is logical that they dispose of it or give it away if someone volunteers to take on the cost of transport.

*White component

** Yellow liquid

*Figure 7. 3 Cheese* being made with the leftover whey**

The lost whey represents the failure and/or inability to take advantage of principles of economies of scope. The small cheese manufacturer produces whey as a waste product because they cannot produce multiple products that more efficiently use the full profile of the fluid milk. This problem has been addressed by large dairy processors that even goes as far as recycling the water evaporated from whey that is used to make protein powder. The water removed is used to wash their facilities and enables some large plants to be disconnected
from city water supplies. This is highly efficient and goes a long way to reduce waste and produce food more efficiently, but the infrastructure investment required to achieve this level of scope is typically not possible for small processors. Small processors are also often not able to take advantage of the economies of scale as this typically requires significant infrastructure investment as well. This again can result in waste as more expensive infrastructure for processing is often more efficient and helps prevent loss of product enabling higher production from the same inputs.

This issue was directly observed in one of the small dairy processor sites visited for this research. Those running the processing business expressed enthusiastic interest in being a zero-waste, sustainable business but they had difficulty finding those who could use their whey. Furthermore, the cost to ship the whey was prohibitive and because they were small and they were not able to find any businesses that could justify the transport cost for relatively small amounts of whey.

Similar issues arise in the produce sectors where small businesses can produce relatively more waste as they are unable to make the initial financial investments to increase the scope of their business by developing products for each component of the whole piece of produce. For example, a small apple farmer does not have the scope to start producing cider from their grounder apples as well as selling table apples. There are some exceptions to this but interview subjects in the case study presented here expressed that focusing on one aspect of production was more economical. Additionally, when infrastructure
investments are not possible, typical for small businesses, equipment used is often not as efficient as it could be. This means that more waste is generated.

While this is a problem that, for these case studies was often associated with small business, it should not be concluded that we should turn to only the largest companies to purchase our food from in order to reduce food waste. What the small businesses lacked in efficiencies they often made up for in their keen interest in the impact their operation had on the local community, including waste generation. They looked at ways to be better local businesses. For example, Dairy Processor 1, aware of the issue of wasted whey was working to develop uses for whey such as whey enriched drinks and feeding it to other animals that could then be turned into food. Furthermore, they offered their whey free to anyone who could take it away. Despite their budgetary limitations many small businesses seem to passionately look to solve issues of waste and provide additional community advantages that are unrelated to efficiency and food waste generation.

7.6 Social Valuation of Food and the Value Chain: Waste in Processing and Retail

At the processing and retail end many supply chain participants argued that waste occurs as a result of the devaluation of food by society. Most people have access to an abundance of food due to low prices and because of this food can seem less important to conserve. When it is undervalued financially and socially it is easier to allow waste to occur.
You can argue that in reality the only reason there is food waste at all is that food is too cheap…. so the reality is that food waste in a sense is a sign of prosperity. Now, I understand of course that in any society, economic society where there’s many, many people that are prosperous, there’s always those that are falling through the cracks. And I think that's what bothers people about food waste is that why, when there’s so much food being thrown out, why are there still people going hungry? (Apple Processor 1, 2017)

Many supply chain participants expressed similar sentiments and suggested the need to alter social perspectives on the value of food. There are elements of this inherent in the discussion around moving from a supply chain to a value chain, where the food product is reoriented to a higher value offering that includes knowledge-based inputs along the value chain. Furthermore, increased communication and transparency in the value chain could facilitate this revaluation.

Some interviewees also noted that there is a trickle-down effect of continually pushing for the lowest cost food product. This means that supply chain participants will continually be looking to decrease costs by decreasing wages and cutting corners. This has a long-term negative impact on the supply chain that is not often considered and works to devalue the final product of the supply chain. But allowing reasonable wages to be paid through appropriately pricing food is good for supply chain participants.

If you analyze what is value? Value it's made not up of only price. Value is price, service, quality, convenience. There are many factors that make up value. A Walmart-ized society only sees price as value. And when people see only price as value, you can't talk with them because they say, "Go away. You're too expensive." They don't see those relationships...when they're in a bind you are there, that's service. There are so many factors in the business relationship that go way beyond price. ... So, when you are a few percent more expensive so that both parties can live, then all of a sudden that little
bit extra can be spent on improving your equipment, on improving your service... if you look at it over a 10-year period, all of a sudden that store has a nice atmosphere in it because everybody can get a decent wage. (Leafy Green Farmer 5, 2017)

Not only are appropriately priced food products good for supply chain participant's standard of living but it is also suggested that it can help reduce waste as supply chain participants become value chain participants who are empowered with respect and information about the offering they are moving through the value chain. By creating a value chain, individual participants should have an increased standing and ownership in the creation and movement of the offering. This happens as price increases as well.

If I paid 50 bucks for a tub of ice cream, a small tub of ice cream, I'm going to make sure that I really like the people that I serve that to. I'm not just giving it out as a gut-filler. I'm going to accompany it with the right baked product. I'm going to ration people as to how much they have because it's 50 bucks. Every spoonful's a buck, so yeah, I would probably take more care. (Apple Processor 6, 2017)

Unfortunately, the problem with increasing costs of food relates back to the comment made by Apple Processor 1. When a society is affluent and can afford abundant food it is hard to see and deal with those who “fall through the cracks.” Those people who are already food insecure will suffer substantially if food prices rise. This issue requires further consideration in order to develop working solutions. Increased social assistance, encouraging home gardening, and allowing hunting and foraging are two possible suggestions discussed in the literature (Ford, 2009; Power, 2005).
7.7 The Bullwhip Effect Echo: The Big Picture

One concept that outlines the potential for food waste within the food supply chain, particularly when food products are offered as bulk deals, is the bullwhip effect. The idea was developed in the early 1990s to describe a phenomenon observed by Proctor & Gamble executives (Lee et al., 1997). The phenomenon observed is the amplification of apparent demand down the supply chain despite the actual demand remaining constant. This distorted information is amplified and creates very large inefficiencies as it moves down the supply chain. A more detailed description is presented in Sections 2.2 and 2.6.

The impact of the bullwhip effect in a non-perishable goods supply chain has the potential to increase costs due to the need to store excess goods and more carefully manage inventory. Unfortunately, the impact of the bullwhip effect in the food supply chain is likely much more detrimental. The increased product demand and the surplus that results is more difficult to deal with due to product perishability and may result in wasted food. This waste of food in the supply chain is a response to the bullwhip effect and is described here as the bullwhip effect echo. This situation is depicted graphically in Figure 7.4.

In the diaper example presented in Section 2.2, once the sale has ended and production of materials for diapers has ramped up along the chain there will be stock piling occurring as supply chain members become aware that they have more products then customers. If this example is altered and a fresh food supply chain is substituted in for the diaper one, there is now a surplus of unneeded products with short shelf-lives. Because of this, all along the supply chain
increased levels of food waste may begin occurring. Furthermore, frequent bullwhips may create institutionalized waste. This could occur as fluctuating orders resulting in over production become more commonplace. Employees may become less concerned with waste of products during surpluses as a matter of habit. These effects are further amplified in more vulnerable product such as leafy greens and some dairy.

The data collected for this dissertation suggests that this may be an issue found in both the dairy and apple supply chains. Communication is the key element that may cause the added waste associated with the bullwhip effect echo and when communication is lacking waste can be generated throughout the supply chain.

The biggest thing we can do to reduce loss is require more lead time from our customers for delivery. The average customer, when they put in an order, they want it the next day. So, if they put in an order, say at two o'clock and they want it delivered the next day or the day after, typically they are items that we would stock … but the lead time is so short, at any given time a customer can go from their average order, because we forecast right? So, they can go from their average order of ten a week and then this week I want twenty because I’m going to do, whatever, just because. This happens a lot with our food service customers because our food service customers are only taking our product just to service other customers. So, if one of their customers has a promotion that information doesn’t necessarily flow back to us. So, food service orders can fluctuate big or fluctuate small. So, let’s say their customer for some reason, this happens at lot actually, a customer can shut down. So now where they were typically selling ten a week to that customer but that customer goes away and their order reduces by ten a week. We don’t necessarily know until we see the orders... Forecasting is inherently wrong, you’re just trying to reduce the amount of error. (Dairy Processor 3, 2016)
Additionally, by removing decision making power and input from supply chain participants it disables them from responding appropriately to changes in product availability and demand.

It would great if there were more people to talk to [in the supply chain]…some distributors have the communication down a lot better than others…some it’s like pulling teeth to get any information…and at least one of [the difficult ones] who is like a huge distributor for us so you can’t cut them out …[these] companies will give us a guaranteed minimum date and we’ll hold them to that but sometimes yeah, it is a little tricky [to avoid short dating]. (Retailer 8, 2017)

One of our companies offers full guaranteed sales on all their products … they even encourage you to order more so your shelves will always be full, even if product expires. Which is, I don’t know how they do that. Because I mean, we’re small and we send back product every week. I can’t imagine what the big guys do… We send them a list of what we didn’t sell every week and they just write it off. (Retailer 8, 2017)

While the centralization of decision making may appear more efficient at first review, it prevents the supply chain from being appropriately reactive to the frequent changes that can occur. In order to improve this scenario, the bullwhip effect should be controlled. Research has evaluated the impact of different communication strategies and increasing supply chain wide communication has proven to be an effective strategy to mitigate the bullwhip effect (Fiala, 2005; Wu & Katok, 2006). The concept of mitigating the waste associated with the bullwhip effect echo is presented in Figure 7.4.
Figure 7.4 The bullwhip and the bullwhip effect echo along the food supply chain and how changes in communication causes change in food waste.
This idea relies on the discussion of improved communication being related to increased efficiencies within the food supply chain. It also recognizes that when fewer inputs (food products) are discarded the costs for manufacturers will likely decrease as they are not being forced to dispose of part of their inventory. Furthermore, to reduce the bullwhip effect echo, it should be possible to provide consumers with the opportunity to purchase food that would typically be discarded at a reduced rate resulting in savings for customers and businesses that are able to recoup costs for purchased products. A good example of this is the sale of ugly fruit and vegetables, or “inglorious fruits and vegetables” by Intermarché for cheaper prices, which resulted in a spike in sales (Personal Communication, 2016).

The use of this concept could help develop research that takes a holistic perspective of the supply chain and identifies reasons waste is occurring throughout. Importantly, it is likely that waste associated with imperfection is linked to the bullwhip effect echo. Members in the food supply chain who experience an overabundance of product are more likely to ship only the best and more visually appealing products down the line. This helps reinforce consumer demand for more perfect products in the future. The consumer becomes accustomed to receiving these perfect food items without being made aware of the repercussions. Despite this, addressing the bullwhip effect echo through improved communication and coordination may lead to food waste reductions in food supply chains through controlling for over production and eliminating some of the ability to be excessively focused on product appearance.
Importantly, more data is needed to truly elucidate this concept. The information presented here provides evidence that alludes to the presence of this effect, but quantitative data collection is needed to map the impact of the bullwhip effect and identify the bullwhip effect echo.

There is also an interesting comparison to be made between the concept of the bullwhip effect, the bullwhip effect echo, and the movement from a supply chain to a value chain that is laden with an increased valuation of the product as it moves to an offering. The discussion surrounding movement to a value chain from a supply chain also encompasses increased communication and transparency, which are elements documented in the literature as means to mitigate the impact of the bullwhip effect, as well as posited here as a means to decrease food waste associated with the bullwhip effect echo. More research is needed in this area but this dissertation proposes that there is a relationship between the bullwhip effect, moving from a supply chain to a value chain with a focus on the offering, and food waste production.

7.8  Is Field Waste, Food Waste?

An interesting question that arose during the process of data collection is related to the definition of food waste used for this research. For the purpose of this research the definition of food waste used describes it as;

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 et al., 2010)
Using this definition of waste, it is logical to conclude that edible produce left on farm is a form of food waste. Interestingly several farmers challenged this idea. They described that it was more efficient to leave the product in the field if they knew it was not going to sell. Leaving product in the field saved human and mechanical resources – funds were not spent on a human harvester and fuels were not burned moving the product. Furthermore, farmers described that produce tilled back into the soil helped build soil quality describing that spreading product on the field “gives back to the land some of what [we] take from it” (Dairy Farmer 10, 2016).

This idea was particularly prevalent in alternative farming facilities that strived to produce in an organic or agroecological manner. These farmers spoke about either leaving non-salable, but edible product directly in the field and incorporating it back into the soil, or through purposeful composting they would then reapplying that material back on the land.

On the conventional farm level, they buy their fertilizer - We grow it. We grow cover crops, we make compost and compost is not something that you just dump behind the barn for four months and then you come and pick it up and take it away, [it’s used here]. (Leafy Green Farmer 5, 2017)

Well, [compost] is everything. Yeah, your fertility cycle is everything. If you don’t have the fertility you need for a crop then there’s no point in putting the crop in the ground … We do a number of different fertilization processes … if you need iron, potassium, phosphorus calcium, boron, look no further than your dandelion patch, right? (Leafy Green Farmer 4, 2017)

The value farmers place on incorporating waste into their farm’s cycle is seen by viewing their compost piles. Many organic and natural farmers allow their free-
range livestock access to forage in compost piles to help off-set losses (Figure 7.5).

![Image of compost pile](image)

*Figure 7.5 A compost pile on an organic produce farm that allowed access to free-ranging fowl for foraging purposes.*

In addition to compost piles, many farmers left product in the field to reduce losses associated with harvesting when they felt it was clear they would not be able to sell the product, or the product would not obtain a reasonable price.

> We often leave things in the field. I think that just composting things in the field is the most efficient way to do it. We leave it in the ground. If it keeps growing a little bit, and it makes more biomass on the surface, then that creates more organic matter. I mean, all I would do if I mowed it down is plant a cover crop, so my crop can be a cover crop if I leave it there. It's a lot more work to haul it out of the field, put it in the compost pile, turn the compost pile, put it back on the field, so we tend to just leave things. (Leafy Green Farmer 3/Distributor 5, 2017)
Let’s say I have something that’s kind of borderline. It’s a little bit, maybe a bit of rot on it or something. Or the leaves are really badly eaten by flea beetle, they’re really holey. So, I can harvest that anyways. I could wash it, I could put it in my cooler, I could drive it to a place that would distribute that food. I can’t give it to my CSA members because that would reflect badly on my business. I would lose members if I brought them bad food. So, I would have to donate it somewhere. So, I bring it somewhere. So, that whole process has just used gas to drive things around. I’ve taken up space in my cooler, which I’m running in the heat. I’ve taken labor to wash it and process it. And now I’m making a donation spot put it in their cooler when chances are they won’t be able to use it. (Leafy Green Farmer 3/Distributor 5, 2017)

The expense and resources required to harvest and move un-saleable product was an issue expressed by many farmers. Some gleaner organizations that work with farmers may be a means to address part of this issue, but it is highly unlikely that farms will ever be able to sell 100% of what they produce. Insects and unpredictable weather patterns will always create some form of waste. With this in mind, however, it is logical for farmers to work to minimize damage. When damage occurs, farmers seek to use the least amount of resources possible to turn the product into something useful.

Because of the information gathered around the impact of field waste, as well as interview subject’s discussions around products being more wasteful based on how much resources have been put into them, it is proposed here that future research into food waste in food supply and value chains use an altered definition of food waste. This definition should include a consideration of energy inputs as well as the final usefulness of the food item. This will give room for a more nuanced discussion of the value an item offers and is more in line with the tenants of a value chain the communicates more fully across all levels and
ascribes to viewing the food items as value laden offerings that are built on at each step of the chain. With this in mind the following definition of food waste is proposed:

Food waste should not be viewed as a dichotomy but instead it should be considered on a spectrum where wholesome edible material that is produced with intention for human consumption but does not end up there may be diverted to other useful applications. These applications include but are not limited to, compost creation, feeding non-human animals, and producing useful but non-edible goods. Consideration of the harm caused (e.g. greenhouse gas generation) by the diversion from human consumption of the food product should be based on the usefulness of the final application as well as the energy inputs used for it to meet its end point.

This definition builds off of the one described by the FAO in 1981 and which is presented in Section 2.3 of this dissertation (Parfitt, Barthel, & Macnaughton, 2010 as well as the waste hierarchy suggested by the EPA (Figure 2.1). Lessons are extrapolated from the case studies presented in this dissertation to create a food waste definition with more nuance. Using this definition will allow for discussions that indicates that food waste should not be treated in clear cut terms. This definition is structured to encourage the creation of product specific metrics to measure the value of various types of food diversion tactics. There needs to be room for a discussion that recognizes the value of products that could be fed to humans but are instead used for other applications. The definition here attempts to provide that flexibility and room to rate the usefulness of different food diversion opportunities.
7.9 Framework for Key Results

This section formally presents 20 hypotheses that are a result of the information presented in each of the case studies and as well as the synthesis of the case information presented in this chapter. Further, these hypotheses were generated to in response to the research propositions presented in Section 2.4 and in line with exploratory case study research, as described by Yin, which suggests that exploratory research should be used for the creation of hypotheses to spur further research (Yin, 2014, loc. 3645-4140). These hypotheses are then situated to fit the conceptual framework as well as to respond to the initial research question and research propositions. The twenty hypotheses generated as a result of this process are presented in Table 7.1.

Table 7.1 Twenty hypotheses generated, for additional research, as a result of the research into bovine dairy, leafy greens, and apples, as well as a cross-case comparison

<table>
<thead>
<tr>
<th>Hypothesis No.</th>
<th>Hypothesis</th>
<th>Section</th>
<th>Section Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reducing withdrawal times will decrease milk wasted on farm</td>
<td>4.6.1</td>
<td>Dairy</td>
</tr>
<tr>
<td>2</td>
<td>Incentive days are contributing to wasted milk on farm due to farmer distrust of processors, their unwillingness to pay shipping overages, and the unpredictability of the incentive system</td>
<td>4.6.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Improving milk transport efficiency will decrease milk losses due to inclement weather events</td>
<td>4.7</td>
<td></td>
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<tr>
<td></td>
<td>Description</td>
<td>Page</td>
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<tr>
<td>4</td>
<td>Increasing butterfat incentivization would decrease waste as fluid volume of milk would decrease while butterfat would increase. Proper incentives would encourage dairy farmers to transitions to cows with genetics that are superior for producing higher butterfat.</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Less experienced leafy green farmers produce more waste then experienced farmers.</td>
<td>5.4.1</td>
<td>Leafy Greens</td>
</tr>
<tr>
<td>6</td>
<td>Good data collection and management practices on leafy green farm results in less food waste generation.</td>
<td>5.4.2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Waste is accumulated in the leafy green supply chain, with levels increasing as the product travels further distances.</td>
<td>5.5.1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Reduction of the amount of handling of leafy greens in a retail environment reduces waste generation.</td>
<td>5.6</td>
<td></td>
</tr>
</tbody>
</table>
| 9 | a. Grounders represent the largest contribution to waste in the apple supply chain.  
b. Grounders contribute to soil quality in terms of organic matter and nutrient profile  
c. Grounders are not food waste because resources are saved by not moving a product through the supply chain that will not sell and turn into food waste at the retail or consumer end. | 6.5.1| Apples |
| 10| a. U-pick apple farms have the most grounder waste because customers are unconcerned about dropping less-appealing apples on the ground.  
b. Keeping u-pick orchards clear of grounders by doing daily sweeps for all grounders will decrease the total volume of grounders collected. | 6.5.2|         |
<p>| 11| High density orchards decrease waste by decrease the number of grounders by making picking and removal of excess fruit easier, as well as by allowing better sunlight access for the fruit which improves colour development and therefore consumer visual appeal. | 6.5.3|         |</p>
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Standardized tray sizes make it difficult for off-sized apples to make it to market – some of these end up in the juicing/processing streams but those that do not are wasted.</td>
<td>6.6.2</td>
</tr>
</tbody>
</table>
| 13   | a. In retail, current display methods of apples encourages food waste by making customers handling the apples easy.  
b. In retail, stacking of apples excessively high, results in food waste.                                                                            | 6.8     |
| 14   | Apple hardiness provides waste reduction opportunities as they are more easily able to be diverted to other sectors.                                                                                        | 6.8     |
| 15   | A farmer with childhood experience on their family farm will be less likely to produce as much food waste as new farmer with no or limited childhood farming experience.                                      | 7.2     |
| 16   | Access to affordable labour decreases the amount of waste produced on farms as farmers are better able to harvest product and move it to the next step in the supply chain.                                  | 7.3     |
| 17   | Increased communications in the supply chain will allow better response to changes in demand and decrease food waste generation overall resulting in the movement from a supply chain to a value chain.                 | 7.4     |
| 18   | Fear and illogical avoidance of economies of scale and scope can contribute to waste, while embracing a combination of economies of scale and scope with small, local supply chain members participation can create a reduction in food waste. | 7.5     |
| 19   | a. The bullwhip effect echo contributes to food waste generation by creating a build-up of excess food in the supply chain that is not needed.  
b. The solution to the bullwhip effect echo involves improved communication and incorporating elements of service dominant logical, such as the offering, and value chain management | 7.7     |
These hypotheses represent gaps in the literature identified in the sections noted in column three of Table 7.1. The evidence presented in the case studies and synthesis chapter suggests that these effects exist, but more research is needed to fully elucidate the relationship between waste and each factor.

The hypotheses from Table 7.1 can be placed on a conceptual framework to identify where most waste related events were noted. This is in line with answering the research question that asks;

**Where and why does food waste occur in dairy, leafy green, and apple food supply chains in Ontario, Canada, and how do supply chain factors impact the production of food waste?**

This question was informed by the objective to interview supply chain participants from every level of three different food types to:

**Develop a framework that can contribute to understanding where, why and how waste occurs in food supply chains and how management systems and common practices impact waste production.**

This framework is presented below.
Using this information as a guide multiple interesting and intersecting investigation can be carried out.

7.10 Conclusion

From the data collected by evaluating and interviewing participants, collecting data from site visits, analyzing industry, and government documents, and reviewing academic literature for three unique food supply chains, common factors were noted. The preceding section presented these commonalities, not to provide conclusive evidence but to suggest generalizable issues noted between the case study research into three food supply chains.
The findings suggest that;

- The hypotheses generated to direct future research were concentrated around the farm level for all products evaluated.
- There is substantial opportunity for more research to address food waste.
- A new definition of food waste is needed that reflects more of the nuance associated with waste food products.

Additional research is needed to further develop each hypothesis generated here. This research has collected supply chain specific data that cannot necessarily be extrapolated to other supply chains but it was possible to generate testable hypothesis and through the comparison between several different case studies more generalizable themes were identified that can be used as branching points for additional research.
Chapter 8 – Conclusion

8.1 Introduction

This chapter discusses the key information presented in chapters 4, 5, 6, and 7. These key results are laid out in a framework presented in Section 7.9 that presents hypotheses from the research looking into food waste that is occurring in the dairy, apple, and leafy green supply chains, as well as across multiple food supply chains in Ontario, Canada. The framework is designed to respond to the research purpose and research objectives presented in Section 2.4. The remainder of this section discusses questions that arose as the contributions this research provides (8.2), recommendations for industry based on this research (8.3), the limitations of this research (8.4), and suggestions for future research (8.5).

8.2 Contributions

The research findings presented in this dissertation contribute to the discussion around where food waste is occurring in supply chains and describes unique features that impact its production in specific supply chains. The data collected is mapped according to where food waste occurs in the three specific supply chains, as well as mapping reasons for waste occurrences common across the supply chains investigated. It has also highlighted some hypotheses for future, more detailed, investigations.

This research also includes a discussion of moving from a supply chain focus to a value chain focus with a more value-laden view of the food items
moving throughout. It moves from an analysis of individual steps in the supply chain to understanding the linkages in a value chain and the degree to which those linkages contribute to waste. It is postulated that this can decrease waste through a changing valuation of the food item and improving communication and coordination through the supply chain. This is also expected to contribute to the mitigation of the bullwhip effect echo, a novel concept associated with food waste and suggested here.

8.2.1 Testable Hypotheses

The research contained in this documented was carried out according to the principles of exploratory case study research as described by Yin (2014). Exploratory research of this nature is used to generate hypotheses which build off the observations and findings of the data collection and analysis, and analysis of supplementary material to indicate where current gaps in the literature exist and to create direction for future research in the form of testable hypotheses. Furthermore, when these hypotheses are mapped against the generated conceptual framework patterns and areas for investigation begin to appear. For this research, on farm investigations appears to be a particularly worth-while avenue to include in investigate on food waste issues and solutions.

8.2.2 Addressing Food Supply Chain Waste with Improved Coordination and Communication

Through investigation of three specific food supply chains it is noted that food waste occurs primarily due to factors that impact multiple levels of the food
supply chain (Figure 7.5). These findings indicate that those looking to address food waste would be most efficient to apply their efforts to supply chain wide strategies.

These finding contribute to the food waste management literature by indicating observed location of food waste in specific and general food supply chains, as well as by suggesting the most efficient areas for the application of effort for further research.

8.2.3 Definitions of Food Waste

The findings here agree with past research that has discussed the need for a unified definition of food waste. This research builds on existing food waste definitions to suggest a new definition of food waste that takes into consideration the multiple valuable aspects of vegetative and animal products that go beyond the value offered to human nutrition.

8.2.4 Talking About Food Waste

There was a general hesitance to speak about food waste. This impacted the number of quality interviews that could be carried out because many participants would not agree to be part of the research. It also likely limited the quality of data that could be collected as interviewees would not answer some questions, provide specific data, and it is also possible that accurate information was not reported due to the fear of being associated with a stigmatized topic. Furthermore, two research subjects pulled out of the research after the analysis was complete due to concerns over waste stigma. This type of reluctance by
supply chain members to speak about food waste is documented in a very limited
capacity in the literature with one recent study noting that their ability to collect
data was only related to a business failure and a soured relationship between the
failed business and other supply chain participants (Ghosh & Eriksson, 2019).
The identification, by this research of this issue contributes to the gap that exists
on this subject.

8.3 Recommendations

Key findings that emerged from this research are found in the conclusions
to each case (4.11, 5.7, 6.9), as well as the hypotheses generation (Section 7.9),
the summary framework discussion (Figure 7.5), and in an introduction of a new
way to view and define food waste that does not necessarily include field waste
(Section 7.8). These findings provide useful recommendations that are context
dependent. Supply chain members and policy practitioners specifically
associated with the dairy, leafy green, or apply supply chains should evaluate the
findings directly relevant to their sectors. More general findings can be gleaned
for the case synthesis section that identifies commonalities between cases
(Sections 7.2 to 7.8).

8.3.1 For Business Owners

Food waste minimization should be viewed as a valuable asset to develop
an optimal value chain. Therefore, it should be considered and monitored
collaboratively by all chain participants. Consideration of the impact food waste
has on external stakeholders can assist with this process and help move from a
supply chain focus to a value chain focus. To achieve this use the tenants proposed by service dominant logic and the concept of the offering, which can provide the understanding and framework needed to move forward. A focus on waste reduction can not only be an ethically sound way to manage a business but also represents cost savings due to a decrease in lost product.

In addition, improving communication and coordination with the intent of reducing the bullwhip effect, may have the ability to decrease food waste through controlling the bullwhip effect echo. At the very least this potential opportunity needs to be explored. By improving communication and focusing on providing an optimal offering, supply chain participants will be maximizing food waste reduction potential. This in turn can save financial and human resources.

8.3.2 For Policy Makers

Food waste in food supply chains is best tackled by approaching the problem holistically. Often issues that cause waste in one segment of the supply chain are creating waste in other areas of the supply chain. Or, as with the example for pack sizing in apples, also preventing waste in one area is causing waste in another area. Implementing policies that encourage communication flows throughout the supply chain may be the most effective means to reduce food waste. Furthermore, supply managed systems present an opportunity to control waste generation through the ability to control the production levels, to a certain extent, of a given product. But supply management bodies must carefully execute plans to ensure they are nimble enough to quickly respond to changes in consumer demand patterns so excessive waste is not created from a failure to
react quickly. Furthermore, supply management bodies should attempt to make decisions that are well researched and take in the perspectives of many stakeholders before enacting change that has the ability to impact many levels of the industry.

8.4 Limitations

The limitations of this research are outlined clearly in Section 3.6. Primarily, the reluctance and fear over sharing waste related data presented the largest barrier to analysis and discussion of the findings. The case study approach provides a unique means to study the food waste issues in a supply chain. It lends itself well to a wholistic collection of data to represent a given supply chain, but it is heavily dependent on the data that case study subjects are willing to provide. For this research many interviewees were reluctant to verbally share their food waste experiences, and none were willing to share numerical data. This made external document analysis important and limited the conclusions that could be drawn.

8.5 Future Research

This research, through the use of case studies, has provided contextual, industry specific data which shows where food waste is occurring in three different supply chains. This information can be used to build understanding in other food supply chain but additional research, using the hypotheses generated, is needed. Additionally, other food supply chain research should be compared to
the findings and hypotheses included in here to corroborate or refute the common factors associated with food waste not in the cross-case comparison

Additional quantitative research is also needed to investigate the presence of the bullwhip effect echo on food waste as well as how communication impacts it. This theory has the potential to provide an efficient way to reduce food waste, once more clearly elucidate, through the application of established research that describes how to mitigate the effects of the bullwhip effect.

Finally, additional investigations into the value associated with incorporating the concept of the offering, from service dominant logic, into a food supply chain to create a more value laden food item and transition towards a value chain is needed. This research can help to identify the impact moving to a value chain orientation can have on food waste accumulation at multiple levels of the chain.

8.6 Conclusion

The data collected here is intended to provide a useful discussion on food waste in supply chains while considering the economic considerations of food businesses. While food waste reduction offers an important environmental and ethical challenge, businesses require logical financial incentives to motivate their action. This dissertation collected data and through analysis suggests that it is possible that food waste reduction strategies can be a lucrative option for profitable companies. Additional research is needed to support or refute this, and
the twenty hypotheses generated by this research present an excellent starting point.

Further quantitative and qualitative data is needed to supplement this early investigation, but this work lays the foundation for further study by pointing to trends observed through exploratory work. The information is presented with the hopes that it provides enough material to spur positive action towards food waste reduction. The document concludes with a quote from an interview subject who explained that “at the end of the day, the industry does what they want to do and that's make money” (Leafy Green Farmer 5, 2017). It is with this in mind that this dissertation was compiled. It is through an awareness that food waste represents a notable social and environmental challenge but also with the knowledge that companies are easiest to motivate when a positive financial case can be presented. It is hoped that any additional research that flows from this research can be framed with clear financial gains and losses, as well as noting important social and environmental impacts, so that researchers are able to show the economically positive aspects of food waste reduction while also highlighting the less tangible value associated with food waste reduction.
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APPENDIX 1: RESEARCH ETHICS APPROVAL

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The members of the University of Guelph Research Ethics Board have examined the protocol which describes the participation of the human participants in the above-named research project and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement, 2nd Edition.

The REB requires that researchers:
- Adhere to the protocol as last reviewed and approved by the REB.
- Receive approval from the REB for any modifications before they can be implemented.
- Report any change in the source of funding.
- Report unexpected events or incidental findings to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants, and the continuation of the protocol.
- Are responsible for ascertaining and complying with all applicable legal and regulatory requirements with respect to consent and the protection of privacy of participants in the jurisdiction of the research project.

The Principal Investigator must:
- Ensure that the ethical guidelines and approvals of facilities or institutions involved in the research are obtained and filed with the REB prior to the initiation of any research protocols.
- Submit a Status Report to the REB upon completion of the project. If the research is a multi-year project, a status report must be submitted annually prior to the expiry date. Failure to submit an annual status report will lead to your study being suspended and potentially terminated.

The approval for this protocol terminates on the Expiry Date, or the term of your appointment or employment at the University of Guelph whichever comes first.

Signature: ________________
Date: November 25, 2016

Stephen P. Lewis
Chair, Research Ethics Board-General
APPENDIX 2: SAMPLE INTERVIEW GUIDES

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take up to approximately an hour. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions or concerns you would like to express before we start?

Contextual Questions
1. What is the total volume of apples that you produce in a season?
   a.) How do you think this compares to other growers?
   b.) Do you know the approximate volume of apples produce in Ontario in a season?
   c.) What about the volume consumed?

2. What varieties of apples do you grow?

3. Have you changed the variety that you grow recently? Why or why not?

4. What are the most popular varieties of apples sold by Ontario farmers?

5. What is your most profitable variety of apple?
   a.) Do you think this is different for other farmers?
   b.) Do all farmers get close to the same price for the same variety of apple?
6. What features (size, colour, etc.) impact the price you get for your apples?

7. Who do you sell your apples directly to (what processors/retailers)?

**Waste and Monetary Level Questions**

8. Out of all the apples you grow, what percentage are you able to sell for human consumption (in any form)?

9. How do you dispose of unsold apples? (dumpsters, compost, etc.)
   a.) Do you use any food waste reclamation strategies? (e.g. second harvest)

10. Out of all the apples you produce, what percentage do you think are composted on farm/used as fertilizer/thrown out in the garbage/used as animal feed?
    a.) What are the reasons apples are transferred to the compost/fertilizer/garbage/animal feed streams cosmetic?
    b.) Are there any other reasons apples may not make it into the supply chain?

11. What are some of the other reasons apples are not purchased from you? (e.g. ordering inaccuracies, changes in demand, etc.)

12. Could you describe the specific reasons for rejection by specific purchasers? For example, why do farm gate consumers reject apples? Why does x processor reject apples? Why does y retailer reject apples?
    a.) Do your purchasers provide you with any written documentation indicating the reason for rejections?
    b.) Are the reasons for rejection consistent?

13. How do you think the amount of unsold (or wasted) apples produced on your farm could be minimized? (e.g. less rejection for appearance imperfection, better communication with purchasers and retailers, etc.)

14. How do you think lowering the number of unsold apples would impact your bottom line? Do you think you could sell your apples for less if fewer went into the compost/waste stream?

15. Do you know approximately how much you sell each apple for and how much you make per apple? (This can be per apple or by the kg – whichever unit you most commonly use. Also, by variety is fine)

16. What type of impact do you think communication has on the amounts of wasted apples?
    a.) Does it increase or decrease it?
Communication Strategy Questions

17. What are your communication strategies when dealing with your purchasers? (e.g. standardized communication patterns – digital confirmation of purchases and shipping, informal emails to communicate problems, etc.)

18. Do you use software to track rejections?
   a.) What program(s)?

19. What types of things should change to improve communication with your purchasers?
   a.) What would you like to see them do differently?
   b.) What could you do differently?

20. Do you have any written agreements in place that outlines how and when you and your purchasers should be communicating? For example, an email from a specific person a week after each shipment to indicate how well products sold and what did not sell well.
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

21. Do you think a more formalized process of communication, setting standard times to communicate and standard information to share, could make your relationship with your purchaser(s) more efficient?

22. Do you think improved communication could help reduce the amount of apples that are wasted/do not make it to the consumer?
Interview Guide 2/Case Study 2: Leafy Green Producers

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take up to approximately an hour. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions are concerns you would like to express before we start?

Contextual Questions
1. What percentage of your leafy greens is grown in greenhouse and what percentage is grown outdoors (in a year period)?

2. What is the total volume of leafy greens that you produce in a year?
   a.) How do you think this compares to other growers?
   b.) Do you know the approximate volume of leafy greens produce in Ontario each year? What is the impact of what your produce?
   c.) What about the volume consumed – are consumers demanding more of any types? Is consumption increasing or decreasing in general, in your estimation?

3. What varieties of leafy greens do you grow?

4. Have you changed the variety that you grow recently? Why or why not?

5. What are the most popular varieties of leafy greens sold by Ontario farmers?

6. What is your most profitable variety of leafy greens h?
   a.) Do you think this is different for other farmers?
b.) Do all farmers get close to the same price for the same variety of leafy greens?

7. What features (size, colour, etc.) impact the price you get for your leafy greens?

8. Who do you sell your leafy greens directly to (what processors/retailers)?

Waste and Monetary Level Questions

9. Out of all the leafy greens you grow, what percentage are you able to sell for human consumption (in any form)?

10. How do you dispose of unsold leafy greens? (dumpsters, compost, etc.)
   a.) Do you use any food waste reclamation strategies? (e.g. second harvest)

11. Out of all the leafy greens you produce, what percentage do you think is composted on farm/used as fertilizer/thrown out in the garbage/used as animal feed?
   a.) What are the reasons some leafy greens are transferred to the compost/fertilizer/garbage/animal feed streams cosmetic?
   b.) Are there any other reasons apples may not make it into the supply chain?
   c.) What are some of the other reasons leafy greens are not purchased from you?

12. Could you describe the specific reasons for rejection by specific purchasers? For example, why do farm gate consumers reject leafy greens? Why does x processor reject leafy greens? Why does y retailer reject your leafy greens?
   a.) Do your purchasers provide you with any written documentation indicating the reason for rejections?
   b.) Are the reasons for rejection consistent?

13. How do you think the amount of unsold (or wasted) leafy greens produced on your farm could be minimized? (e.g. less rejection for appearance imperfection, better communication with purchasers and retailers, etc.)

14. How do you think lower numbers of unsold leafy greens would impact your bottom line? Do you think you could sell your leafy greens for less if fewer went into the compost/waste stream?

15. Do you know approximately how much you sell each unit of leafy greens sells for and how much you make per unit?
16. What type of impact do you think communication has on the amounts of wasted leafy greens?

**Communication Strategy Questions**

17. What are your communication strategies when dealing with your purchasers?

18. Do you use software to track rejections?
   a.) What program(s)?

19. What types of things should change to improve communication with your purchasers? (e.g. standardized communication, more regular communication, etc.)
   a.) What would you like to see them do differently?
   b.) What could you do differently?

20. Do you have any written agreements in place that outlines how and when you and your purchasers should be communicating? For example, an email from a specific person a week after each shipment to indicate how well products sold and what did not sell well.
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

21. Do you think a more formalized process of communication, setting standard times to communicate and standard information to share, could make your relationship with your purchaser(s) more efficient?

22. Do you think improved communication could help reduce the amount of leafy greens that are wasted/does not make it to the consumer?
Interview Guide 3/Case Study 3: Bovine Dairy Producers

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take up to approximately an hour. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions are concerns you would like to express before we start?

Contextual Questions
  1. How much milk does your farm produce per year (Liters)?
     a.) How do you think this compares to other producers?
     b.) Do you think you produce more or less and by how much?
  
  2. Do you know the approximate volume of milk produced in Ontario in a year?
  
  3. Do you produce any organic milk?
  
  4. Is your farm 100% Holstein?
  
  5. Do you ever have off-breed cows in the herd for any reason (e.g. to change milk fat percentage)?
  
  6. What are the advantages/disadvantages of other dairy breeds?
  
  7. Could you provide me with a brief overview of the dairy quota system, your opinion on it and how it impacts your business. (this question is to provide key background information on the different levels of
understanding of quota in Ontario – understanding what you understand will help me better interpret the information I collect

8. What is the milk collection schedule on your farm? (e.g. every morning at 7am with pick up from the holding tank occurring at 2pm)
   a.) What is the maximum time that milk will stay in your holding tank?

Waste and Monetary Level Questions

9. What percentage of the milk produced on your farm goes gets shipped out? (how much is saved to feed calves, disposed of due to antibiotic use/contamination, etc.)
   a.) How do you think your facility compares to other farms – do you think you have higher or lower levels of rejection?
   b.) Do you have a standardized procedure for dealing with rejected milk (due to antibiotic use or contamination or other)?

10. How often is milk rejected at your farm (by the milk truck driver)?
    a.) How do you think your facility compares to other farms – do you think you have higher or lower levels of rejection?
    b.) Please explain the rejection procedure and who does the testing including what tests are performed and what results cause rejection?
    c.) How do you dispose of rejected milk? (sewer, pour out on ground, etc.)
    d.) What is the procedure for dealing with rejected milk? Do you have a standardized procedure that is written out?
    e.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

11. How would decreasing the amount of rejected milk impact your bottom line?
    a.) How much do you make (gross and profit) per liter of milk?

12. How much milk (percentage of total) is kept to feed the calves?
    a.) Approximately what percentage of the milk that is saved for calf consumption is used and how much is disposed of?

13. How much milk do you keep for home use?
    a.) What percentage of this milk is disposed of?

14. How do you think the amount of rejected milk produced on your farm could be reduced?

15. What type of impact do you think communication from the DFO (Dairy Farmers of Ontario) has on the amounts of wasted milk on farm?
    a.) Could improved communication reduce the amount of rejected milk?
Communication Strategy Questions

16. Is there standardized communication when dealing with the DFO (e.g. do they provide a report about milk quality and quantity after every pickup)?

17. Do you use software to track rejections? What program(s)?

18. How could the communication with the DFO improve? (e.g. standardized communication, more regular communication, etc.)

19. Do you have any specific strategies that you use to try to improve the efficiencies of your interactions with the DFO?

20. Do you have any written agreements in place that outline how communications occur with the DFO or an example of a regular report you have received from the DFO?
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

21. Do you think a more formalized process of communication, setting standard times to communicate and standard information to share, could make your relationship with your purchaser(s) more efficient?

22. Do you think improved communication could help reduce the amount of wasted milk that occurs on the farm?

Additional Questions to ask as needed:

1. What happens to when your milk output exceeds your quota?
2. How much mastitis do you see on your farm (percentage of cows at any given time)?
3. How much milk is lost due to mastitis? (percentage per pick-up)
4. How much milk is lost due to any other health issues?
5. What are those health issues?
6. Do you have backup generators?
   a. How long can they run?
   b. Have you ever lost milk due to power outages (backup generators not having enough capacity)?
   c. Have you ever had to dump milk due to inability of the milk truck to pick-up (e.g. because of road blockages due to weather)
7. What tests do the milk truck drivers do before picking up your milk?
   a. What tests do they do on samples of your milk at the dairy? Do you receive a report detailing these results?
8. Have you ever had a batch of milk refused by the milk truck driver? For what reason(s)?
   a. Are there any penalties for having a batch of milk refused?
   b. What would you do/do you do with a batch of milk that is refused?
Interview Guide 4/Case Studies 1 & 2: Apple and Leafy Green Processors/Distributors

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take just over an hour. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions or concerns you would like to express before we start?

Contextual Questions
1. What product do you bring through your facility?
2. Which products contribute the largest volumes in your facility?
3. Who are your largest purchasers/customers?
4. Who are your biggest suppliers?

Note: Although you deal with multiple food products, for my work I am concentrating on apples and leafy greens. My questions will be primarily focusing on how your facility deals with these products and the strategies that you use that may impact their movement in the supply chain.

5. Who are your largest apple purchasers/customers?
6. Who are your largest apple suppliers?
7. What volume of apples do you process in your facility per year?
   a.) How do you think this compares to other processors? (higher or lower)
8. Of the apples that you process, what are the main food products you produce from the whole apple?
   a.) Which products are the most profitable for you? Why?
   b.) Which products are in the highest demand?
   c.) Has this changed recently?
   d.) How much does this change by season/year?

9. Who are your largest leafy green purchasers/customers?

10. Who are your largest leafy green suppliers?

11. What volume of leafy greens do you process in your facility per year?
   a.) How do you think this compares to other processors (higher or lower)?

12. Of the leafy greens that you process, what are the main food products that you produce from the raw product?
   a.) Which products are the most profitable for you? Why?
   b.) Which products are in the highest demand?
   c.) Has this changed recently?
   d.) How much does this change by season/year?

Waste and Monetary Level Questions

13. What percentage (per shipment) of raw apples do you typically reject at the farm gate?
   a.) What are the reasons for rejecting apples at the farm gate?

14. What percentage (per shipment) of raw leafy greens do you typically reject at the farm gate?
   a.) What are the reasons for rejecting leafy greens at the farm gate?

15. Which apple products (raw, juice, sauce, etc.) are most often rejected by your purchaser(s) – please list by purchaser?
   a.) What percentage (per shipment) of these apple products are rejected?
   b.) What are the reasons for product rejection – please list by product?

16. Which leafy green products (raw prepackaged, raw bunches, frozen, etc.) are most often rejected by your purchaser(s) – please list by purchaser?
   a.) What percentage (per shipment) of these leafy green products are rejected?
   b.) What are the reasons for product rejection – please list by product?

17. Do you think your company’s rejection rates are significantly different than other facilities? Why or why not?

18. How much do you think rejection rates impact your bottom line?
19. Do you think reducing the number of rejections could save you money?

20. Could some of these savings be passed on to your purchasers?

21. How do you dispose of your rejected apples and leafy greens? (e.g. dumpster, compost, etc.)
   a.) Are you part of any food waste recovery efforts? (e.g. second harvest)

Communication Strategy Questions

22. How does your facility communicate rejections to your producers?
   a.) Is it in a standardized way (occurring at set intervals with specific information contained) or on an as needed basis?

23. How do your purchasers/customers communicate product rejection to you?
   a.) Is it in a standardized way (occurring at set intervals with specific information contained) or on an as needed basis?

24. What strategies could improve communication with your producers and purchasers/customers?

25. Do you use a specific tracking software?
   a.) Is this system linked across the supply chain?

26. What information is contained in a rejection communication (e.g. reason for rejection, number rejected, ways to improve, etc.)?

27. Would you like to see more/better communication?

28. How could this communication be improved? (e.g. standardized communication, more regular communication, etc.)

29. Do you have any written agreements in place that outlines how communications occur with your purchasers or an example regular report you receive from them?
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

30. Do you think improved communication could help reduce the amount of waste that occurs in the supply chain?
Interview Guide 5/Case Study 3: Bovine Dairy Processors/Distributors

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take just over an hour. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions are concerns you would like to express before we start?

Contextual Questions
1. Please explain your role in the dairy supply chain?
   a.) How does your facility fit within the context of supply management/quota?

2. Where does the milk/dairy products come from that is shipped into your facility?
   a.) Where do you ship your products to (most to least)?

3. Do you deal with organic and regular dairy products?

   NOTE: If the processor/distributor deals with organics, each answer to the questions proceeding should be followed with a follow up question asking the interviewee to compare their organic and regular dairy products.

4. What milk products do you produce? (e.g. fluid milk, cheese, yogurt, etc.)
   a.) In what proportions? (e.g. most to least, percentages, etc.)
   b.) How do you think this compares to other processors/distributors?

5. What volume of dairy products do you deal with each year?
   a.) How does this compare to other processors/distributors?
6. Which products have the highest level of processing?

7. Which products are most in demand?
   a.) Have you seen this change in the last 4 months? /Have you seen this change in the last year? OR How does demand change by season and by generation?
   b.) Which product do you spend the most to produce? (highest processing costs)
   c.) Which product do you spend the least to produce? (lowest processing costs)
   d.) Which product provide you with the largest profit margins?
   e.) Do these costs change much? (e.g. due to new technology or increased efficiency)

Waste and Monetary Level Questions
1. Do you ever reject batches of milk/dairy intended for your facility?
   a.) For what reason(s)?
   b.) How much milk is rejected (%)? (yearly/monthly/shipment/etc.)

2. What percentage of milk/dairy do you think your competitors are rejecting?
   a.) For what reasons?

3. How much do you think rejection rates impact your bottom line?

4. Do you think reducing the number of rejections could save you money?

5. Could some of these savings be passed on to your purchasers?

6. How do you dispose of your rejected dairy? (e.g. sewer, dumpster, compost, etc.)
   a.) Are you part of any food waste recovery efforts? (e.g. second harvest)

7. How much processed milk product (milk handled in your facility) is rejected or disposed of and does not make it to the next step in the supply chain? (e.g. percentages)
   a.) What are the reasons for rejection/disposal?
   b.) How do you think this compares to your competitors? (e.g. percentages, higher or lower)
   c.) Do you think they have the same rejection/disposal reasons?

Communication Strategy Questions
8. How are product rejections communicated in the supply chain? (e.g. standardized digital communications, informal emails, etc.)
   a.) How do your purchasers/customers communicate them to you? (e.g. standardized digital communications, informal emails, etc.)
b.) How do you communicate rejections with your producers? (e.g. standardized digital communications, informal emails, etc.)

9. How do you think this compares to other processors/distributors?

10. Is there regular general communication with your suppliers?

11. Is there regular general communication with your purchasers/customers?

12. What strategies could improve communication with your producers and purchasers/customers?

13. Do you use a specific tracking software?
   a.) Is this system linked across the supply chain?

14. What information is contained in a rejection communication? (e.g. reason for rejection, number rejected, ways to improve, etc.)

15. Would you like to see more/better communication?

16. How could this communication be improved? (e.g. standardized communication, more regular communication, etc.)

17. Do you have any written agreements in place that outlines how communications occur with your purchasers or an example regular report you receive from them?
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

18. Do you think improved communication could help reduce the amount of waste that occurs in the supply chain?
Interview Guide 6/Case Studies 1, 2 & 3: Apples, Leafy Green and Bovine Dairy Retailer

Opening remarks
Thank you for agreeing to meet with me.

As I included in the consent letter, this interview should take about 2 hours. We’ve agreed to split this into y sessions with today taking about x minutes. Is that still ok?

I would like to reiterate that your information will be coded, meaning all identifying information such as individual’s names and company or product names will be removed from the interview transcript or other documents. The code for this information will be stored on password protected computer in an encrypted file. You will be given a reasonable opportunity (2 weeks) to review the any reports containing information related to your interview before they are released and any requests to make changes or remove information provided by you will be obliged. If at any other point you would like some or all your information extracted from this research it will be removed immediately.

As I also mentioned previously, I would like to record this interview so that I can focus on our discussion today without needing to take too many notes. Is that still ok?

Do you have any questions or concerns you would like to express before we start?

Contextual Questions
1. What is the square footage of your facility?
   a.) Of your square footage could you describe the percentages allocated to bakery, produce, dairy, meat, frozen, grocery and deli?

2. Approximately how many products (SKUs) do you have?
3. What percentage of these products/SKUs are organic?
   a.) Out of all your dairy products, what percentage sold are organic?

Note: An apple/leafy green/dairy product is something that contains at least 50% of product in question.

4. What size garbage bins does your facility have?
   a.) How many bins does your facility have?
   b.) How often are they emptied?
   c.) Is your garbage sorted? (cardboard recycling, compost, etc.)
   d.) Do you use any sort of food waste rescue program? (e.g. second harvest)
5. What is your cost of goods sold? (/year)?

6. What is the demographics of your customer base/what’s your typical customer like?

7. Who are your biggest suppliers?

Note: Although you deal with multiple food products, for my work I am concentrating on three products – apples and leafy greens from produce as well as dairy products. My questions will be primarily focusing on how your facility deals with these items. For clarity and ease of discussion I would like to discuss one item at a time.

**Apples**

8. What are the main apple products that you sell (e.g. whole, juice/cider, sauce, etc.)?
   (Note: Apple product = a food product that has more than 50% apple by weight on a dry matter basis)

9. Which products are the most popular sellers?

10. What volumes of apples and apple products move through your facility per year?
    a.) How do you think this compares to other retailers? (higher or lower)
    b.) What is the percentage breakdown of each? (e.g. 50% whole apple, 30% juice, 10% sauce, 10% cider)

11. When (what season) do you sell the most apples and apple products?
    a.) What other things (e.g. holidays) impact apple sales?

12. Who are your largest apple and apple product suppliers?

**Apple Waste and Monetary Level Questions**

13. What percentage (per shipment) of raw apples do you typically reject from your suppliers?
    a.) How often are those shipments?
    b.) What are the reasons for rejecting apples?
    c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)

14. What percentage (per shipment) of apple juice/cider do you typically reject from your suppliers?
    a.) How often are those shipments?
    b.) What are the reasons for rejecting apple juice/cider?
    c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)
15. What percentage (per shipment) of apple sauce do you typically reject from your suppliers?  
   a.) How often are those shipments?  
   b.) What are the reasons for rejecting apple sauce?  
   c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)  

16. Which apple products (raw, juice, sauce, etc.) are most often rejected by your customers?  
   a.) What percentage (per shipment) of these apples products are rejected?  
   b.) What are the reasons for product rejection – please list by product?  

17. Do you think your store’s rejection rates are significantly different than other facilities?  
   a.) Why or why not?  

Leafy Greens  
18. What are the main leafy greens products that you sell? (e.g. raw whole, frozen, pre-made salads, etc.)  
   (Note: Leafy green product = a food product that has more than 50% leafy green by weight on a dry matter basis)  

19. Which products are the most popular sellers?  

20. What volumes of leafy green products move through your facility per year?  
   a.) How do you think this compares to other retailers? (higher or lower)  
   b.) What is the percentage breakdown of each? (e.g. 50% raw prepackaged, 30% raw bunched, 20% frozen)  

21. When (what season) do you sell the most leafy green products?  
   a.) What other things (e.g. holidays) impact leafy green sales?  

22. Who are your largest leafy green product suppliers?  

Leafy Green Waste and Monetary Level Questions  
23. What percentage (per shipment) of raw prepackaged leafy greens do you typically reject from your suppliers?  
   a.) How often are those shipments?  
   b.) What are the reasons for rejecting leafy greens?  
   c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)  

24. What percentage (per shipment) of raw leafy greens, in other forms, do you typically reject from your suppliers?
a.) How often are those shipments?
b.) What are the reasons for rejecting bunches?
c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)

25. What percentage (per shipment) of frozen leafy greens/spinach do you typically reject from your suppliers?
a.) How often are those shipments?
b.) What are the reasons for rejecting frozen spinach?
c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)

26. Which leafy green products (raw prepackaged, raw bunched or frozen.) are most often rejected by your customers?
a.) What percentage (per shipment) of these leafy green products are rejected?
b.) What are the reasons for product rejection – please list by product?

27. Do you think your store’s rejection rates are significantly different than other facilities?
a.) Why or why not?

Bovine Dairy

28. What are the main milk and milk products that you sell (e.g. fluid, cheese, ice cream, yogurt, cream, butter, etc.)?

29. What are the highest selling organic milk and milk products?
a.) How do their sales compare to the regular versions of these products?

(Note: Milk product = a food product that has more than 50% dairy by weight on a dry matter basis)

30. Which products are the most popular sellers?

31. What volumes of milk and milk products move through your facility per year?
a.) How much of this is organic?
b.) How do you think this compares to other retailers? (higher or lower)
c.) What is the percentage breakdown of each? (e.g. 40% fluid, 30% cheese, 10% ice cream, 10% yogurt, 5% cream, 5% butter)

32. When (what season) do you sell the most milk and milk products?
a.) What other things (e.g. holidays, time of day, etc.) impact milk and milk products?
b.) Is there a seasonal effect on sales of organic milk and milk products?

33. Who are your largest milk and milk products suppliers?
a.) Please break them down by product and organic vs. regular production.

Bovine Dairy Waste and Monetary Level Questions
34. What percentage (per shipment) of fluid milk do you typically reject from your suppliers?
   a.) How does organic compare to regular milk?
   b.) How often are those shipments?
   c.) What are the reasons for rejecting fluid milk?
   d.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)

35. What percentage (per shipment) of cheese do you typically reject from your suppliers?
   a.) How often are those shipments?
   b.) How do organic and regular cheese products compare?

36. What are the reasons for rejecting cheese products?
   a.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)
   b.) How do organic and regular cheese products compare?

37. What percentage (per shipment) of ice cream do you typically reject from your suppliers?
   a.) How often are those shipments?
   b.) What are the reasons for rejecting ice cream?
   c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)
   d.) How do organic and regular ice cream products compare?

38. What percentage (per shipment) of cream do you typically reject from your suppliers?
   a.) How often are those shipments?
   b.) What are the reasons for rejecting cream?
   c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)
   d.) How do organic and regular cream products compare?

39. What percentage (per shipment) of butter do you typically reject from your suppliers?
   a.) How often are those shipments?
   b.) What are the reasons for rejecting butter?
   c.) How do you think this compares to other facilities? (higher lower, different reasons – less or more picky?)
   d.) How do organic and regular butter products compare?
40. Which dairy products (fluid, cheese, ice cream, yogurt, cream, butter) are most often rejected by your customers?
   a.) What percentage (per shipment) of these dairy products are rejected?
   b.) What are the reasons for product rejection – please list by product?
   c.) Do you think your store’s rejection rates are significantly different than other facilities? Why or why not?
   d.) How do organic and regular dairy products compare for levels of rejection by consumers?

**Apples, Leafy Greens, and Bovine Dairy**

*Communication Strategy Questions*

41. How does your facility communicate rejections to your suppliers?
   a.) Is it done in a standardize way (occurring at set intervals with specific information contained) or on an as needed basis?

42. How do your customers communicate product rejection to you?
   a.) Do you track this?
   b.) How? (e.g. electronically, informally, etc.)

43. What strategies could improve communication with your suppliers? (e.g. standardized digital communications, informal emails, etc.)
   a.) What would you want to communicate to your suppliers to help reduce the amount of products rejected by your customers/that you need to throw out?

44. What strategies could improve communication with your customers? (e.g. surveys, informal info collection by employees, etc.)
   a.) What would you want to communicate to your customers to help reduce the amount of rejected apples/leafy greens/dairy?

45. Do you use a specific tracking software? Is this system linked across the supply chain?

46. What information is contained in a rejection communication (e.g. reason for rejection, number rejected, ways to improve, etc.)?

47. Would you like to see more/better communication in general across the supply chain?
   a.) How could communication be improved?

48. Do you have any written agreements in place that outline how communications occur with your purchasers or an example regular report you receive from them?
   a.) If you have any documentation that describes how you and your purchaser(s) communicate, would you mind sharing this information? I
can take a digital copy. It will be treated with the same level of anonymity as the rest of the information gathered here today.

49. Do you think improved communication could help reduce the amount of waste that occurs in the supply chain?
   a.) Do you see any big differences between the organic and regular supply chains in terms of communication?
APPENDIX 3: PROVIDED REQUIRED INFORMATION

Research suggests that food waste is occurring at multiple points along the food supply chain. Furthermore, research also suggests that improved communication may be a means to reduce the levels of waste and improve overall efficiency within the food supply chain. To properly evaluate this and develop strategies to better deal with the waste issue the researchers involved in this project at the University of Guelph are looking to collect information from supply chain participants. It is hoped that they can provide their thoughts on the waste and communication perceptions and issues within the food supply chain in order to help develop a cohesive strategy to deal with the issues.

As a food supply chain participant, you are being asked to participate in this study. Participation involves completing a one-on-one interview with the principle investigator. The interview can take approximately 1 to 2 hours but timing is flexible based on the needs of individual schedule’s and the amount of information they would like to provide. The analysis generated from the interview will be presented to the interviewee prior to publication for their endorsement to ensure accuracy. Responses will be coded and individually identifying information will not be provided in the final report. Quotes from the interview may be used in the final report but they will not be directly attributed to the participants. Instead a general identifier will be used. For example, a quote from an egg producer in Southern Ontario will be attributed to an “egg producer in Ontario” followed by the year that quote was collected.

This project has been reviewed by the University of Guelph Research Ethics Board for compliance with federal guidelines for research involving human participants. If you have any questions regarding your rights and welfare as a research participant in this study (REB # 16OC025), please contact: Director, Research Ethics; University of Guelph; reb@uoguelph.ca; 519-824-4120 ext. 56606. You do not waive any legal rights by agreeing to take part in this study.

If you have any other questions and/or would like to sign up for an interview time please contact Mychal-Ann Hayhoe at 519-277-3222 or mhayhoe@uoguelph.ca. Interviews can be conducted wherever and whenever is most convenient for the interviewee.
APPENDIX 4: CONSENT TO PARTICIPATE FORM

Investigation into Food Waste Reduction Strategies in the Food Supply Chain.

You are asked to participate in a research study conducted by Mike von Massow and Mychal-Ann Hayhoe, from the departments of Food, Agricultural & Resource Economics and the department of Hospitality, Food & Tourism Management at the University of Guelph. The results of this investigation will contribute to the PhD dissertation of Mychal-Ann Hayhoe.

You are being invited to participate in this research because of your involvement in the food supply chain. Specifically, your experience with apples/leafy greens/dairy is of interest to us. We are hoping to speak to you about this product in order to learn from your involvement in this industry.

If you have any questions or concerns about the research, please feel free to contact Mike von Massow: Faculty Supervisor at 519-824-4120 extension 56347.

PURPOSE OF THE STUDY

This study is designed to assess the levels of food waste in the supply chain as well as establish causal linkages to practices that can be associated with waste generation. These can be individual practices that can be improved through relatively simple changes, but more specifically we hope to identify systematic practices that can be associated with waste. These include procedures and policies implemented across the supply chain that lead to waste, as well as infrastructure deficits that can be associated with waste.

PROCEDURES

If you volunteer to participate in this study, we would ask you to agree to be interviewed in a one-on-one setting for up to 1 hour or 2 hours.

We also ask that, if you feel comfortable doing so and you believe it would be acceptable according to your organization’s management, you provide us with any documents that may be useful in supporting the contents of your interview or useful for this research in general. For example, documents showing the quantity of different food products your firm sell or purchase or documents that show reasons for discarded products. These documents will be used as supporting evidence and data towards our final interpretation of the interviews.
We will only be asking that you be interviewed once, although it is possible to break the interview into two or three shorter periods if that is preferable for the participant. The interview can be conducted at the location most convenient for you and it will be arranged to best fit your schedule. You will not be contacted again unless you indicate your desire for a follow up or a copy of the research results.

Following the interview, any reports containing information related to your interview will be sent to allow a reasonable opportunity (2 weeks) to remove or modify any or all of the information related to you, before the reports are released. The time required to review this material can range from approximately 15 to 60 minutes.

**POTENTIAL RISKS AND DISCOMFORTS**

The risks to the participants are minimal as we will endeavour to ensure that all identifying information is kept confidential. In the unlikely event that our encryption and password protection system is hacked there can be some social and financial risks related to participating. If controversial comments are made and read by other industry participants this may impact your social standing and therefore the quality and quantity of business you do.

The interview questions are designed to reveal insights into the participants’ professional functions and opinions. Because of this there is little risk that the interview would cause significant psychological stress. Despite this, a participant who is significantly stressed by their job may find some or all of the interview process psychologically uncomfortable.

**POTENTIAL BENEFITS TO PARTICIPANTS AND/OR SOCIETY**

There are not direct benefits to the participant. Indirectly the information gathered may be useful. With a world population poised to exceed 9 billion and more than half of the current world population experiencing a persistent state of food insecurity there is an increasing need to develop new tactics to provide food. Food waste has been established as issue of increasing concern but strategies for accurately identifying quantities and causes have been deficient. This research is designed to begin to quantify volumes of food waste in specific food supply chains as well as seek out broad strategies to explain and address the reasons for this waste.

**PAYMENT FOR PARTICIPATION**

There is no direct compensation for participants.

**CONFIDENTIALITY**

*Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study.*

The risks to the participants are minimal as we will endeavour to ensure that all identifying information is kept confidential. Interview data will be encrypted and
stored on a password protect computer in an encrypted file. As no computer security system can be deemed 100% infallible there is a limited chance that systems could be hacked and data could be stolen. The researchers will take every reasonable precaution to avoid this occurrence.

Although some quotations collected in the interview may be used in the final research report the information will not be attributed to the specific participant. Instead a general identifier will be used to indicate the origin of the quote. For example, a quote taken from an dairy producer located in Southern Ontario will be described as from an “dairy producer in Ontario.”

Interview data will be collected on an audio recorded. Once recorded the interview will be transcribed and that data will be coded to remove personally identifying information. The key code will be stored on a password protected computer in an encrypted file. Any physical copies of the audio interview will be stored in a locked cabinet in a locked room. Mike von Massow and Mychal-Ann Hayhoe will be the only people with access to this cabinet. The audio recordings will be erased once the data has been transcribed.

**PARTICIPATION AND WITHDRAWAL**

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may exercise the option of removing all or part of your data from the study. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

Any reports containing information related to your interview will be sent to you to allow a reasonable opportunity (2 weeks) to remove or modify any or all of the information related to you, before the reports are released. Once the research has been published the information associated with your interview will not be removable. At any time you may ask for your interview data to be deleted from the investigator’s database.

**RIGHTS OF RESEARCH PARTICIPANTS**

i. This project has been reviewed by the Research Ethics Board for compliance with federal guidelines for research involving human participants (REB# INV034).

ii. If you have any questions regarding your rights and welfare as a research participant in this study (REB #16OC025), please contact: Director, Research Ethics; University of Guelph; reb@uoguelph.ca; 519-824-4120 ext. 56606.

iii. You do not waive any legal rights by agreeing to take part in this study.

**SIGNATURE OF RESEARCH PARTICIPANT**
I have read the information provided for the study “Investigation into Food Waste Reduction Strategies in the Food Supply Chain” as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

____________________
Name of Participant (please print)

☐ Check box if you consent to having your interview transcript and consent form sent by email.

SIGNATURE OF WITNESS

____________________
Name of Witness (please print)

____________________   ________________
Signature of Witness                  Date
APPENDIX 5: SURVEY OF MOST COMMON DAIRY, APPLE, AND LEAFY GREEN PRODUCTS IN 10 RETAILS STORES

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<th>Store 6 - Kitchener</th>
<th>Store 7 - Kitchener</th>
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APPENDIX 6: NEWS STORIES FOUND THROUGH A SEARCH OF CBC, PUBLISHED BETWEEN 2008 AND 2017 ABOUT LEAFY GREEN PRODUCTS

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