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Traceability in the Canadian Dairy Processing Sector

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TRACEABILITY

in the

CANADIAN DAIRY PROCESSING SECTOR

by

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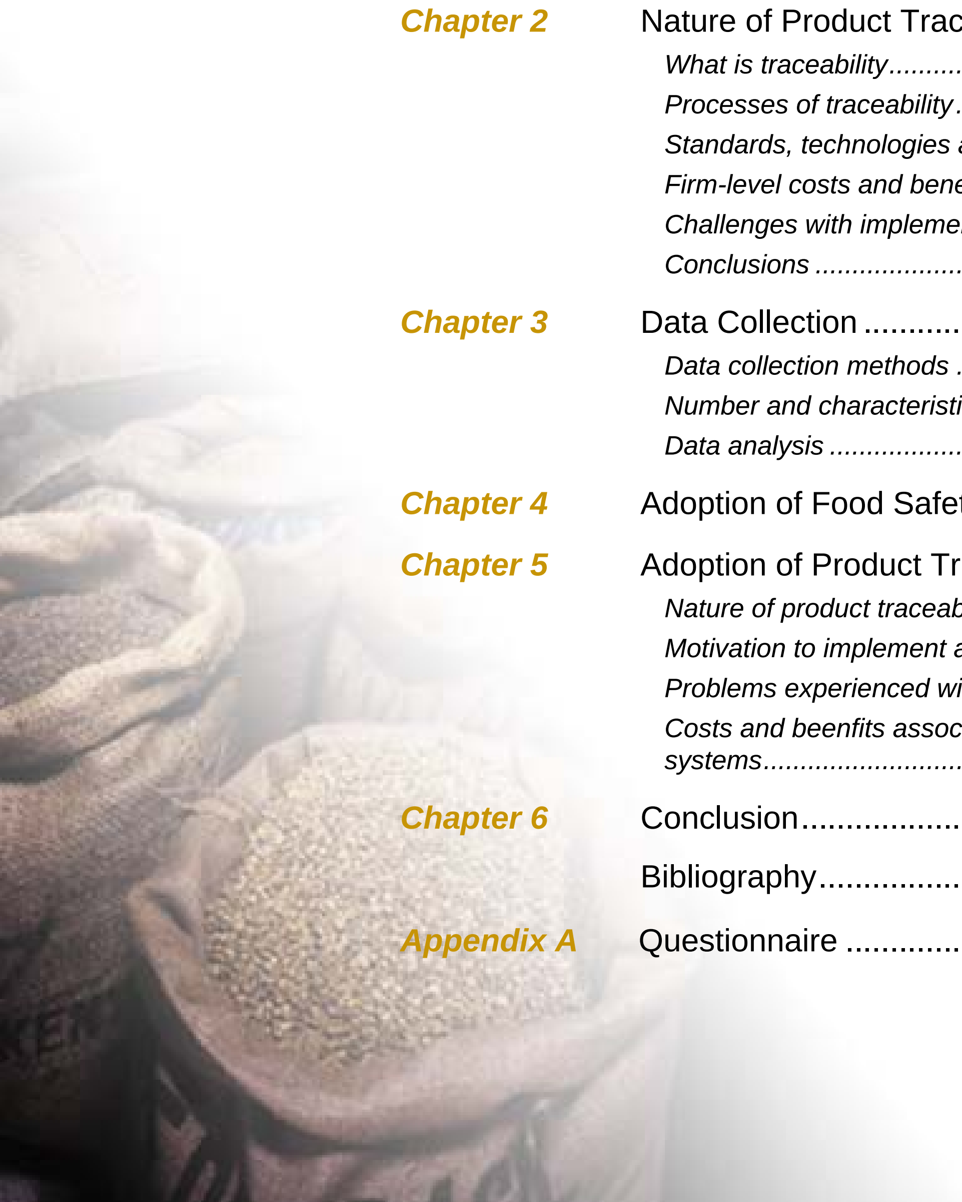

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FOREWORD

The agri-food chain today is significantly different from that of twenty years ago. Changing consumer demands, knowledge intensive technology, North American integration, and globalization have all contributed to the evolution of the different segments of the chain, which include input suppliers, agricultural producers, food processors, and food distributors. Growing consumer awareness and demand for food safety and quality attributes are the main drivers behind the implementation of food safety and quality traceability systems. The ability to trace products through the supply chain provides a mechanism by which food safety problems can be more effectively controlled and/or credence attributes signalled to consumers. This is necessary if Canada is to meet the challenges of the rapidly changing global food market, exploit niche markets for products, and become more competitive in the long run.

This report is part of Agriculture and Agri-Food Canada's (AAFC) Performance Report Series. The purpose is to create a picture of food safety and quality systems, an important ingredient to the competitiveness and profitability of the entire agri-food value chain, and to support a more informal discussion on changes in the agri-food value chain and the challenges and opportunities it faces. The information in this report will provide a reference point for determining the preparedness of the agri-food value chain to meet the challenges of the dynamic global food market.

This report examines traceability in the dairy processing industry to better understand the drivers behind the implementation of product traceability, the challenges facing the industry and the costs and benefits experienced by firms which have implemented traceability systems. Using a census mail-out survey of all dairy processing facilities across Canada, the report finds that most dairy processing plants had implemented a system of product traceability and are able to trace forward and backwards. However, the systems implemented tend to be technologically primitive with only one-third of the plants using computer-based systems. Staff motivation and training are significant challenges to implementation of traceability systems. Inspections/audits and laboratory testing are also significant cost impediments to implementation. Developing strategies related to staff attitudes and training, and improving technology would allow the sector to take further advantage of the potential benefits from product traceability.

Executive Summary

Traceability is the process of tracking the flow of product through a supply chain. The primary objective for a food traceability system is to create the ability to identify quickly, and remove from distribution, food which may present a public safety risk. However, there are other reasons for implementing traceability systems, including meeting regulatory or customer requirements and using the information provided by traceability systems to improve supply chain operation and efficiency. End-to-end traceability requires supply chain partners to collect, store and share information. Traceability systems are typically built on internal company information systems, so effective food chain traceability requires agreement on which information will be exchanged and integration of supply chain information systems to the extent needed to support information exchange.

Although the role and importance of traceability in Canadian food safety systems is increasing, it is far from reaching its potential. This study examines traceability in the dairy processing industry to better understand the drivers behind the implementation of product traceability in the Canadian dairy processing sector, the challenges facing the industry and the costs and benefits experienced by firms which have implemented traceability.

The study involved two phases of data collection. The first stage involved six in-depth semi-structured interviews with quality assurance managers at dairy processing facilities in Ontario and Manitoba. The first stage analysis formed the major input to the design of the mail survey used in the second stage. This postal survey of 386 processing facilities across Canada generated a response rate of around 34 percent.

Almost 94 percent of the respondents were headquartered in Canada and 56 percent operated out of one location. The average size was around 49 employees, slightly above the national average of around 45. The annual sales for the majority of respondents were in the $501,000 to $10 million range. More than 71 percent of revenue came from sales within their home province and 65 percent came from products sold under the company's own brand. Although only 29 percent produced more than two types of dairy product, the majority of respondents manufactured products with at least one 'speciality' characteristic, products for which traceability would be an asset in confirming product characteristics.

Only 38 percent of respondents had actually implemented hazard analysis and critical control point (HACCP), but 49 percent had implemented some other food safety control system, most commonly good manufacturing practice (GMP), Canadian Food Inspection Agency (CFIA) standards, provincial standards and organic standards. Only five plants were ISO 9000 certified.

Almost 91 percent of the respondents to the survey had implemented a system of product traceability with slightly more of those able to trace forward than backwards. The maximum level of traceability for almost 90 percent of plants with a product traceability system was one day's production, but almost half could trace to multiple batches within a single day's production or to individual production units. Traceability was far from perfect; with 96 percent of plants able to trace back at least 90 percent of their production to this maximum level, while 82 percent could trace back all of their production to this level. Only one-third of the plants used computer-based systems and the remainder employed paper-based systems, suggesting that these systems were relatively 'unsophisticated' and limiting the potential operational benefits that might result.

The most important motivations for adopting traceability were meeting customer requirements, improving company image and anticipating regulatory requirements. Almost one-quarter of plants with product traceability had experienced a product recall and/or withdrawal in the three years prior to the implementation. Thirty-five percent of the firms with traceability had experienced one or more product recalls since implementing their traceability system. Reducing production costs and obtaining higher prices were generally less important to most firms accessing new markets or increasing existing market share.

Further analysis using principle components analysis identified three broad categories of motivators; **market drivers** such as customer requirements and enhancement of supply chain coordination, managing the risks and consequences of **product recall** and customer complaints and **legal requirements** including regulations and liability standards. When survey respondents were clustered according to these three broad motivators, around half were classified as being driven by the management of risks related to product recalls, customer complaints and legal requirements. These were generally smaller dairy processing facilities mainly selling products under their own brand name through small food retailers. Market drivers were more important for plants with greater sales to the major supermarkets and/or more involvement in producing private level products for food retailers or food service operators.

Issues related to staffing were the main impediments to traceability and the main costs both during implementation and on-going operations. Survey respondents identified problems associated with staff motivation, training and time as significant challenges and costs. Problems were most commonly associated with production and supervisory staff, but also applied to managerial and administrative staff. Support and cooperation of customers was also considered important during implementation and challenges around information flow were identified as impediments, both internal record-keeping and issues related to poor information flow between suppliers and customers. Additional significant on-going costs also included inspections/ audits and laboratory testing.

Most plants indicated that they had derived at least some benefits from product traceability, particularly in the company's perceptions by customers and/or regulators and in the ability to meet customer and/or regulatory requirements. More tangible benefits, such as impacts on product prices and the number of recalls, were considered less significant. Most plants reported no change in production costs, while 73 percent experienced a decrease and the remainder saw costs increase. Around 60 percent of respondents considered that the benefits of implementing a system of product traceability in their plant had exceeded the costs, generally in accordance with prior beliefs. Only 28 percent of respondents considered that the benefits exceeded their expectations and 44 percent indicated that the costs they had incurred exceeded their *a priori* expectations, particularly in staff time.

The results of the study suggest that product traceability has been implemented widely in the Canadian dairy processing sector. Even though these implementations have been at a relatively primitive level technologically, dairy processors see benefits that equal or outweigh costs in most plants. In spite of significant staff challenges, there appear to be good economic and commercial reasons for implementing a system of product traceability. Developing strategies related to staff attitudes and training and improving technology would allow the sector to take further advantage of the potential benefits from product traceability.

Chapter 1
Introduction

Throughout the agri-food system greater emphasis is being given to the implementation of food safety and quality metasystems (Caswell et al., 1998) as a means of addressing growing consumer concerns about the safety and quality of food products and to manage the business risks associated with public regulations and liability (Henson and Caswell, 1999). Examples include Hazard Analysis and Critical Control Point (HACCP), Good Manufacturing Practice (GMP) and ISO 9000. Such metasystems are increasingly being incorporated, in whole or in part, into public regulations. The drive towards mandatory implementation of HACCP in federally-registered facilities in the Canadian meat processing sector is but one example.

Traceability is increasingly being seen as one important component of food safety systems within the agri-food system. Indeed, a range of public and private initiatives are underway in a number of countries aimed at establishing some degree of traceability of agricultural and/or food products through supply chains. While traceability is arguably an integral element of established food safety and quality metasystems, such as HACCP, it is increasingly being seen as a distinct metasystem in its own right and is being integrated into public regulations, most notably in the European Union (EU).

Food safety and quality became predominant drivers of the agri-food system in high-income countries through the 1990s and into the new millennium. In the case of food safety, a series of high profile food scares (see for example Warland et al., 2001), alongside the emergence of new food safety risks (such as E. coli 0157:H7), served to highlight the inherent weaknesses of prevailing food safety controls in the minds of both consumers and scientists. While Canada was not itself (at least until recently) subject to the same history of food safety scares as, for example, the EU, it is evident that consumer concerns have been rising (Hobbs et al., 2001). Thus, both public regulations and private standards in Canada have been evolving in a similar manner to many other high-income countries, driven by both the concerns of consumers at home and the demands of major export markets.

Alongside consumer concerns about the safety of the foods that they eat, a range of quality attributes have emerged as drivers of the demand for agri-food products (Hobbs, 2004). Most of these attributes relate to the manner in which agricultural and food products are produced and are credence-characterised in the absence of appropriate monitoring or quality signals. Examples include organic foods, animal welfare standards, country of origin labelling and products free of genetically-modified organisms (GMOs). Certain food safety issues also have the same characteristics, for example pesticide residues or Bovine Spongiform Encephalopathy (BSE). Monitoring or quality signals that are considered unreliable, or that are absent altogether, increase the transaction costs for both downstream agribusinesses and food consumers.

Both food safety and food quality concerns have acted as drivers for the increasing emphasis on traceability in agri-food systems, particularly in the case of meat and other animal products. On the one hand, the ability to trace products through the supply chain provides a mechanism by which food safety problems can be more effectively controlled and/or credence attributes signalled to consumers. On the other hand, the ability to preserve the identity of products with distinct quality attributes is necessary if agribusinesses are to exploit niche markets for such products. Thus, traceability is both of interest to social welfare in Canada and the competitiveness of the agri-food system, both in national and international markets. To date, however, there has been a paucity of research on the level and nature of traceability systems in the Canadian agri-food system (exceptions include Hobbs et al., 2001; Hobbs, 2003; 2004)

The aim of the current study is to assess the level and nature of traceability in the Canadian dairy processing sector, placed within the context of food safety and quality metasystems more generally. In particular it focuses on the following research questions:

- What are the main factors motivating the adoption of product traceability in general and how do these vary by firm size, product type, markets served, etc.?
- What are the costs and benefits associated with the adoption of product traceability practices and how do these vary by firm size, product, type, markets served etc.?
- What constraints are faced in implementing product traceability and how do these vary by firm size, product, type, markets served, etc.?

Thus, the research aims to shed light on the drivers behind the implementation of product traceability in the Canadian dairy processing sector and the experiences of businesses that have, or at least have attempted to, implement some form of traceability. In so doing, it provides the first in-depth study of product traceability in the Canadian food processing sector and, will hopefully form the basis of a series of studies in other sub-sectors.

Before proceeding to the original data collection and analysis undertaken as part of the current project, the next chapter provides an overview of traceability within the context of food supply chains. It discusses the processes involved in achieving traceability of products through the supply chain and the standards, technologies and processes that support the establishment of traceability systems. Finally, the firm-level costs and benefits and implementation problems associated with product traceability are discussed, with reference to the very limited number of previously published studies.

CHAPTER 2

NATURE OF PRODUCT TRACEABILITY

Over the next few years the Canadian food system will undergo major changes as the industry grapples with issues related to food traceability, specifically issues around the level needed, types of systems and technologies to be employed and measuring the true costs and benefits of traceability to consumers and members of food supply chains. We examine traceability in the context of the Canadian food industry.

What is traceability?

The most common and broadest definition of traceability is that established by the International Organization for Standardization (ISO):

> *"Traceability is the ability to trace the history, application or location of an entity by means of recorded information" (ISO 8402, 1994).*

In the agricultural and food sectors, a broad definition is necessary. These sectors include numerous types of organizations and production systems and traceability may be applied to achieve a variety of different objectives. Golan et al. (2004) expanded the definition to incorporate the concepts of product flow and product attributes.

> *"Traceability systems are record-keeping systems designed to track the flow of product or product attributes through the production process or supply chain."*

In defining traceability, an important distinction is made between tracking and tracing. Tracing refers to the ability to trace a product from a particular point in the chain back to its source. Where this ability exists, it is only used in the event of a problem, to allow companies and/or regulatory agencies to follow the history of a product back to its source. Tracking is used to identify the route from a particular point in the chain forward. In reality, both tracking and tracing capabilities may be required in the event of a food safety problem to capture all contaminated product. Thus, a contaminated product identified in one store could be traced back to a lot and then tracked forward to other retail outlets to be withdrawn. Both tracing and tracking capabilities can be used to help ensure the provision of specific quality attributes, as will be discussed later.

The controversy over the extent of traceability required in the agriculture and the food industry is evident from the distinct definitions employed in different regions of the world. Efficient Consumer Response (ECR) Europe (2004)[1] uses a definition which is more explicit to the extension of the traceability concept to non-food producers that are involved within food supply chains:

> *"Traceability is the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution."*

According to the UK's Food Standards Agency (2004), "stages of production, processing and distribution" refers to any element of the supply chain (including imports) from and including the primary production of food, up to and including its sale or supply to the final consumer. Where relevant to food safety, this definition also encompasses the production, manufacture and distribution of feed.

The EU's *General Food Law* describes traceability as an 'end-to-end process' whereby companies collaborate to optimize the interfaces between them. ECR Europe considers that the definition of traceability may differ from one operator to the next depending on their business activities, position in the supply chain (upstream or downstream) and prevailing legislation (ECR Europe, 2004). Traceability is viewed more widely as a way to meet consumers' expectations for product safety and quality.

According to the Farm Foundation (2004), agribusiness firms and producers in the US are uncomfortable with the European definition of traceability, considering it to be broader than needed to achieve specific food safety or assurance goals. Thus, traceability is defined as:

> *"The efficient and rapid tracking of physical product and traits from and to critical points of origin or destination in the food chain necessary to achieve specific food safety and, or, assurance goals."*

The Farm Foundation (2004) also recognizes that in terms of defining traceability and assurance, "one size does not fit all"; distinct food supply chains require different levels of traceability and assurance for both food safety and quality assurance. Further, traceability systems have to be different for each intermediary in order to fulfill their individual objectives related to traceability. The Farm Foundation's definition also brings a new mission for traceability, namely achieving assurance through the supply chain. In this context, assurance appears to be the ability to certify certain aspects or attributes of a product that have to pass through multiple intermediaries before reaching the final customer.

Within the context of food supply chains, most specifically for meat and meat products, Hobbs (2004) identifies the following functions of traceability systems related to food safety and quality:

- ***Ex post* traceability:** In the event of a food safety or other serious product problem *ex post* traceability allows food to be traced back to the source and thus allows the affected product to be identified and withdrawn. The social costs decrease as there will be fewer people exposed to contamination from unsafe food. This system reduces costs after a problem has arisen, meaning that *ex-post* traceability is a latent capability. Information is collected and stored

1. *ECR is a supply chain model that has been developed by the US grocery and food industry in the 1990's. This model will be explained further in the text.*

along the chain but it is only used in the event of a problem. A further feature of *ex-post* traceability is the ability to locate the source of a problem and assign liability to an individual member of the chain so that costs may be correctly allocated to the firm responsible.

- ***Ex ante* traceability:** Traceability also provides a mechanism for quality verification by providing continuous tracking and reporting on the quality attributes of products moving along the supply chain. *Ex ante* traceability reduces information costs for customers arising from quality verification provided that they can trust a label that assures credence attributes (for example organic production, animal welfare standards, etc). This function is an active capability in that data collection and reporting is an ongoing activity along the chain.

Traceability itself is not a guarantee of anything in particular, but can provide the means through which specific attributes are supplied and may be a prerequisite for food suppliers to enter certain markets (Viaene et al, 1998):

> "Once effective and efficient traceability systems are established, concrete steps towards quality management (QM) and supply chain management (SCM) are feasible. From the consumer or public point of view, SCM focuses on improving the performance of the system through delivering guaranteed safe, desirable and quality food in a cost-effective manner. Quality management relates to all processes in the organisation which contribute to delivering quality, as defined by the consumer. A major component deals with quality assurance and control. The traceability system by itself guarantees nothing, but it is clearly a prerequisite to supply chain and quality management in the meat industry."

In the minds of most industry managers, a clear distinction is made between traceability and the concepts of SCM and QM. We note that traceability systems can be designed to support or validate products with respect to quality standards along the chain and can provide the information required for efficient and effective supply chain and quality management within agri-food value chains.

This view is consistent with that of Can-Trace, a Canadian industry initiative designed to promote traceability in Canadian food chains and develop the information standards needed to support the implementation of traceability systems. Can-Trace promotes traceability as a means to achieving a range of objectives related to food safety, quality, cost reduction and supply chain improvement (Can-Trace, 2004). In so doing, traceability is considered as an integral part of the business system which should not be developed in isolation from logistical processes, food safety programs (for example HACCP) and quality programs. Can-Trace also recognizes the importance of meeting international standards and trade. Thus, it employs the ISO definition of traceability which is recognized internationally by the major organizations involved in traceability such as the United States Department of Agriculture (USDA), Electronic Commerce Council Network (ECCNet), Efficient Consumer Response ECR Europe, European Article Numbering and the Universal Code Council (EAN•UCC)[2] and Electronic Product Council (EPC) Global.

2. *EAN is the global supply chain standards council. EAN•UCC standardizes electronic bar codes and electronic data interchange standards to support SCM (http://www.ean-ucc.org/).*

Processes of traceability

Traceability systems are designed to trace and track products and their components through the supply chain. Although traceability must be an end-to-end process, it is accomplished in a supply chain consisting of independent firms with different stand-alone information systems. Thus, to accomplish end-to-end traceability, supply chain partners must undertake three key activities.

- **Data collection:** The system must be able to capture the required data. Although this may be accomplished using paper based methods, more effective technologies like bar code scanners, radio frequency identification, handheld computers and specially engineered input devices are simplifying data collection and allowing more data to be captured.

- **Data storage:** Once collected, the data must be organized and stored in a database which allows different options for retrieval and search.

- **Data transmission and sharing:** The system is only effective if data can be exchanged between supply chain intermediaries. Thus, traceability systems must have systems integration capabilities, connecting hardware and software, which allows diverse corporate systems to communicate.

Key variables in describing and defining a system of traceability include the concepts of 'direction' and 'position'. ECR Europe (2004) has defined traceability track and trace in terms of two directions:

- **Tracking** is the capability to locate a product based on specific criteria wherever it is within the supply chain. This is the critical feature of any traceability system because companies must be able to identify and locate their products within the supply chain in order to withdraw or recall them whenever necessary. This capability is sometimes referred to as the 'one step forward' legal principle; if each chain member can identify the next step in the chain then a product can be tracked forward from any point all the way to retail distribution.

- **Tracing** is the capability to identify the origin and characteristics of a product based on criteria determined at each point of the supply chain. This is the critical feature of a traceability system because companies must be able to determine the identity and source of products received in an accurate and timely manner whenever necessary. This is referred to as the 'one step backward' legal principle.

The location of products at any point in time may be described relative to the position of an intermediary in the supply chain. In defining intermediaries and their location in the supply chain, the concepts of 'downstream' and 'upstream' processes and 'internal traceability' are useful. According to EAN France (2001), upstream, downstream and internal traceability are defined relative to an individual supply chain partner, which is usually a company or a processing site:

- **Upstream** traceability describes the procedures and tools implemented to locate an event that has already occurred, before the partner concerned has become legally or physically responsible for the products. Following a product trail upstream is what is referred to as tracing.

- **Downstream** traceability describes the procedures and tools implemented to locate an event that has occurred after the transfer of property and/or after the physical transfer of products from the partner to a third party. Following a product trail downstream is what is referred to as tracking.

- **Internal** traceability occurs within organisations. Although traceability is a process for tracing and tracking products within the whole chain, a great deal of this activity occurs within organizations. Thus internal traceability takes place independent of commercial partners.

Since traceability systems really consist of a chain of independent traceability systems employed by supply chain partners, the effectiveness of traceability through the chain depends on the efficiency and accuracy of these individual systems, as well as on the interfaces between them. Supply chain members will have different incentives for implementing traceability and their individual systems will be shaped by their different objectives. For example, a firm seeking to meet regulatory requirements or to minimise the risks associated with food safety and recalls would only require a traceability system which could manage *ex-post* traceability, and would implement a system where information is stored and available if needed, but not used otherwise. On the other hand, a firm which was also using traceability as a means of achieving supply chain improvements would employ a system where more information is collected and used on a regular basis to analyze operations and to help identify problems and opportunities for improvement.

The capabilities and operations of any traceability system can be defined according to three dimensions (Golan et al, 2004):

- **Breadth** describes the amount of information the traceability system records.

- **Depth** refers to the number of steps backwards or forwards the system tracks in the supply chain.

- **Precision** reflects the degree of assurance with which the tracing system can pinpoint a particular food product's movement or characteristics.

Specification of these variables characterizes the system within each intermediary. Taken together through the entire chain, these variables ultimately characterize the traceability capabilities of an entire supply chain. Ultimately, the capability of the entire system will be defined, or perhaps more accurately, constrained, by its weakest link.

Effective traceability requires consistency in data along the supply chain and agreement is required among partners on the information that needs to be collected from suppliers as well as from internal operations. It is necessary to specify which information collected is stored internally and which is shared with supply chain partners, and the conditions for data sharing. Can-Trace (2004) argues that effective tracking and tracing requires linking information and product flow. Thus, in 2004 Can-Trace developed minimum information standards for the Canadian agri-food industry.

Standards, technologies and systems supporting traceability

ECR Europe (2004) has established guiding principles around traceability and the technologies used to develop and implement traceability systems. ECR Europe describes the fundamental process that all parties involved must follow in order to achieve traceability and recall in an efficient manner systematically associating the physical flow of materials, intermediate and finished products with the flow of information about them (ECR Europe, 2004). According to Can-Trace (2004) and ECR Europe (2004), the EAN-UCC[3] standards are the most recognized business language or coding system in the world. These standards are applied to the agri-food industry from farm to retail distribution, and also are used by numerous others industries. The EAN-UCC standards are based on four key traceability principles:

- **Unique identification of products, logistic units and locations:** This is the basic principle that any trade item and/or location must have a unique number to facilitate trace and track along the supply chain. A trade item is a logistic/consumer unit that includes all forms of the product flow. A logistic unit could be a truck load, pallet, bin or a box, while a consumer unit is the product form that the consumer buys at the retail level. Consumer units are often referred to as SKUs (Stock-Keeping Units). Other information required to uniquely identify a lot related to the location unit, series and lot number.

- **Traceability data capture and recording:** Traceability implementation requires that each product has a unique number which is recorded by each intermediary along the supply chain. Each company has to record a Serial Shipping Container Code (SSCC), the logistic unit number which is shared between partners and/or stored by each trading partner wherever relevant and applicable (ECR Europe, 2004). According to Can-Trace (2004) there are two types of data required for traceability: master and transactional data. Master data is information that seldom changes, and applies to product, party and location information. This includes information such as product description, buyer identifier, location etc. Transactional data is unique to each individual transaction. Examples include lot number, shipment identifier and shipment date. EAN-UCC standards allow supply chain participants to track and trace products through the use of automatic data capture with bar coding or radio frequency identification (RFID) and automatic messaging such as electronic data interchange (EDI) (Can-Trace, 2004).

- **Links management and traceability data retrieval:** While the data used for traceability must be consistent across organizations, the systems and technologies do not necessarily have to be. One of the challenges for traceability is creating effective links between organizations and developing compatible systems for data retrieval in the event of a problem. Current traceability systems recognize the need to support different internal systems and integrate them with those of supply chain partners only as far as needed to allow for track and trace activities.

- **Traceability data communication:** Traceability requires the sharing of information among the partners of the supply chain. The main challenge is to synchronize the product flows with the information flows. At this point EDI is the most common means of sharing information along the chain.

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3. ECR Europe (2004) - EAN•UCC key traceability principles were published in the EAN•UCC Traceability Implementation Guideline in February 2003.

See CIES (2005) for a more complete description of the technologies and the process for implementing a traceability system in the food industry.

Firm-level costs and benefits of traceability

From a technical perspective, full chain traceability is achievable. However, from an economic and/or business perspective traceability must offer an overall net benefit which exceeds the implementation and on-going costs incurred through investments in traceability systems. A problem in this respect is that business decision-makers may not fully comprehend the associated costs and/or benefits, especially if they are intangible in nature (see for example Henson and Holt, 2000).

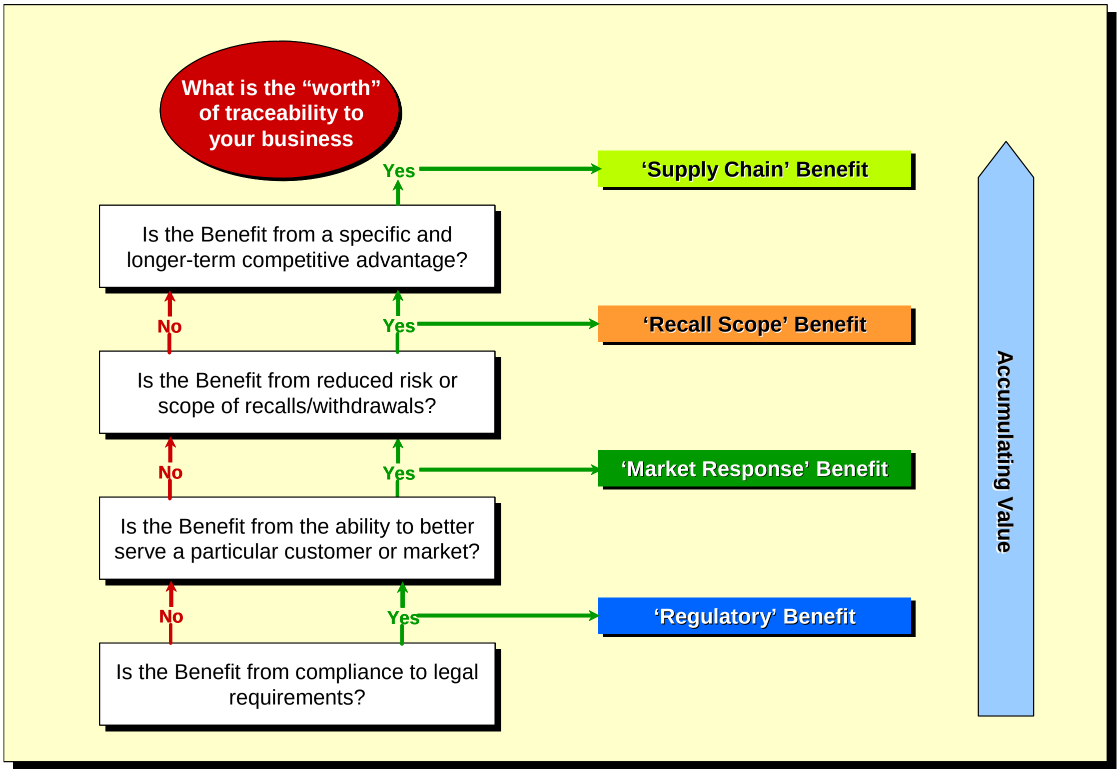
Broadly, the costs of establishing a system of traceability are relatively easy to define, although perhaps less easy to measure. Can-Trace (2004) distinguishes between start-up costs such as hardware, software, systems engineering and training, and on-going costs' including traceability supplies (for example tags and forms), training, support and system upgrades. Golan et al. (2004), however, take a broader perspective, distinguishing between the costs of record keeping and the costs of product differentiation. Record keeping costs are incurred to develop and implement the system and are associated with information collection, training staff and system maintenance. Product differentiation costs are incurred in keeping products and/or sets of product attributes separate from one another for tracking purposes. This includes the cost of certifying that a product meets certain standards and/or has attributes that are the basis of differentiation from a similar product. For example, organic produce has been grown under specific methods that are the basis of differentiation for some consumers. In this case a traceability system can certify along the supply chain that a product meets specified organic standards.

The benefits of traceability are both difficult to define and measure. This reflects the fact that these benefits may be spread across many elements of a business, and individually may be quite small, and are largely intangible in nature. According to Sparling and Sterling (2004) there are four major categories of benefits that can be associated with traceability systems (Figure 2.1): 1) regulatory benefits; 2) market and customer response benefits; 3) recall and risk management benefits; and 4) supply chain benefits. They recommend that managers approach these as a hierarchy of potential value and assess each category of benefits.

Regulatory benefits

One of the main drivers for adopting traceability is to meet actual or potential regulatory requirements, making traceability a prerequisite for some markets. Firms seeking to assess the benefits of complying with regulatory requirements will compare the value of accessing regulated markets with the value of alternate markets where traceability is not required, and measure the difference in contributions to gross margins or profits (Sparling and Sterling, 2004). For many managers, meeting regulatory requirements for specific markets is viewed simply as a cost. For most firms the need to comply with regulatory requirements may be sufficient to justify investing in traceability, although this is not viewed as sufficient to recover the required investment.

Figure 1: The benefits of full chain traceability



Source: Sparling and Sterling (2004)

Market and customer response benefits

Food safety issues can cause consumers to ask for traceability or push retailers to adopt such systems as a means of reducing their liability. For example, in the UK retailers have adopted traceability as a means of assuring customers of the safety of their products. More recently retailers have begun to insist that suppliers implement traceability systems as a means of improving supply chain operations. For example, Wal-Mart has recently asked their major suppliers to implement RFID technology as a means of exerting greater control and cost effectiveness in their supply chains (Progressive Grocer, 2004).

Traceability can also serve to differentiate products for selected credence attributes by supporting identity preservation along the supply chain. By assuring supply chain partners and consumers that a product meets specific production standards, such as organic or GMO-free, supply chain members can potentially extract a premium. One question pondered by researchers is whether consumers actually place a value on traceability through the food supply chain. Unfortunately, research into consumer willingness to pay (WTP) for traceability does not provide a clear answer. Indeed, Buhr (2002) suggests that it is impossible to say whether consumers actually demand traceability per se, or the product attribute. Meuwissen et al. (2003), for example, were not able to identify consumer 'willingness to pay' a price premium for food safety-related systems and certification schemes. At the same time, however, some studies have identified a clear premium associated with traceability, specifically within the context of meat (Hobbs, 2002).

Hobbs (2002) analyses the consumer 'willingness to pay' for traceability, food safety and on-farm production assurances in the Canadian pork and beef sectors using laboratory-based experimental auctions in eastern and western Canada (Hobbs, 2002). Consumers ranked food safety as the most valued attribute, with an attached premium of around 20 percent. Traceability was ranked behind both food safety and farm production assurances, with a premium of seven percent. A product with all three characteristics had a collective price premium of 40 percent. Dickinson and Bailey (2002) have conducted a similar study in the United States, which identified a price premium for traceability of around 17 percent.

Dickinson and Bailey (2005) suggest, further, that American, Canadian, British and Japanese consumers, on average, are willing to pay non-trivial positive amounts for traceability in supply chains for beef and pork. At the same time, however, they recognise that a significant proportion of consumers in these countries are not willing to pay extra for traceability and/or the product attributes that are verified by such systems. This makes it difficult, perhaps, to extract a price premium except in the context of premium or niche products.

Recall and risk management benefits

Governments can impose traceability as a risk mitigation tool to protect public or animal health (Sparling and Sterling, 2004). By imposing information rigour on the supply chain, traceability may reduce the probability of a food safety problem as well as reducing the severity of consequences should a food safety problem occur. The ability to track products forward and trace products back is also important in the case of a recall and can significantly limit the recall scope; the amount of product which must be recalled. In pilot studies in the produce and beef industries, Sparling and Sterling (2004) observed reductions in scope of up to 85-90 percent of the size of the recall without traceability in place.

Supply chain benefits

The information provided by a real-time traceability system can act as a significant tool for raising the efficiency of supply chain management, supporting higher quality and/or lower costs. The ability to track and locate products accurately in the supply chain can reduce product spoilage or out-of-date product losses, lower inventory levels, quicken the identification of suppliers and raise the effectiveness of logistics and distribution operations (Sparling and Sterling, 2004). Traceability can also act to diminish transaction costs along the supply chain, for example by diminishing the information asymmetries associated with credence characteristics (Hobbs, 2004) and the costs of supplier identification, contract negotiation, verification and enforcement (Lazzarini, 2001; Meuwissen et al., 2003).

Interestingly, during pilot studies in the Canadian and US food industries, managers frequently did not perceive these aspects as potential benefits of implementing traceability. However, when asked to consider all of the possible uses of the information from a real-time traceability system, managers were frequently able to identify significant efficiency and cost saving opportunities (Can-Trace 2004). One further supply chain benefit which is often overlooked is the value created in improved relationships between organizations, whereby traceability forms the basis for developing and analysing partnerships between supply chain members.

Unfortunately, there is a paucity of research that translates these potential costs and benefits into the real incentives for the adoption of traceability, not only in Canada but globally. Further, studies that do exist are rather general and fail to provide an accurate measure of the true costs and benefits of traceability.

Viaene and Verbeke (1998) provide an analysis of traceability in the Belgian poultry meat chain under the lens of supply chain management. The original incentive for establishing traceability in this sector related to the need for effective disease control systems. Traceability also provided opportunities to establish a basis for quality management and to reward producers for applying good husbandry practices. However, while these authors suggest that the Belgian poultry meat chain exemplifies the need for a full-chain approach to build a sustainable competitive advantage, they offer little in terms of firm economic evidence.

Buhr (2002) examines a series of case studies of European meat and poultry supply chains with the objective of identifying incentives for adopting traceability, understanding the costs and benefits and assessing their potential for application in North America. However, the primary focus is on the technology of traceability, identifying the value of electronic information systems for storing and moving the data collected and for identity preservation rather than providing any real insight into the costs and benefits of traceability more broadly and the associated incentives/disincentives for adoption.

Although there is a paucity of empirical studies on the incentives to adopt traceability, parallels can be drawn to a larger literature on food safety and quality metasystems such as HACCP and ISO 9000. For example, several studies have examined incentives for the adoption of the ISO 9000 group of standards in the food processing sector in the US (see for example Capmany et al., 2000), UK (see for example Zaibet and Bredahl, 1997) and several other countries (see, for example, Turner et al., 2000). There is a smaller literature on the incentives to adopt HACCP and other enhanced food safety systems (see for example Henson and Holt, 2000). While this literature fails to address the specific technical and economic characteristics of traceability, it does provide some insight into the range of incentives for the adoption of related systems. For example, a key theme through this HACCP-related literature is the prominent role of market-based incentives (for example customer requirements) and internal business benefits (for example efficiency) alongside regulatory requirements (Henson and Caswell, 1999).

Challenges with implementing traceability

Can-Trace (2004) identifies two key factors that can impede the adoption of traceability in the Canadian food industry. First, there is a general lack of understanding and analysis of the costs and benefits associated with traceability. This leads managers to conclude that the costs of traceability far outweigh any potential benefits. Thus, traceability tends to be viewed solely as a potential regulatory requirement and not as a management tool. Second, systems for traceability in the food supply chain are relatively new and, in most cases, no single clear approach is apparent. Thus, investment in a traceability system appears risky to managers. Further, concerns over security of corporate data lead to a general lack of willingness to share data and strong resistance to involvement in any traceability model which requires a central data repository.

In considering impediments to the adoption of traceability, it is important to take both a dynamic and global perspective. Traceability is already being mandated in the EU and voluntarily adopted to varying degrees in food chains within North America and elsewhere. Pressure to adopt traceability and new supporting technologies is coming from consumers, retailers and governments. At the same time, the focus of competition within agribusiness is shifting from company-to-company to value chain-to-value chain, where each value chain consists of many companies organised along the supply chain. In this context, traceability provides a tool to differentiate the products of each value chain and to manage more efficiently the production and distribution of those products. At the same time, the costs of implementing traceability are declining, while the potential effectiveness of such systems is increasing. At the current time the major obstacle to the adoption of traceability is management perception of the costs relative to the benefits. There is a need to make these 'more visible' through research, which is one function of this study.

Conclusions

This chapter has illustrated the complexity of product traceability within the context of food supply chains and the wide range of definitions employed by various agencies even to describe the basic concept of traceability. In this respect, key variables include the 'direction' and 'position' of a traceability system and the breadth, depth and precision of information collected and communicated by such systems. A range of standards, technologies and systems have evolved to support the establishment of product traceability, although there is very little empirical evidence on the extent to which these have been employed in practice. Likewise, there is a paucity of previous studies on the factors motivating the implementation of product traceability and the associated costs and benefits at the firm level. It is these gaps in the current literature that this study aims to address. Thus, the next chapter now describes the processes of data collection and analysis employed in the current study and the characteristics of the respondents to the survey that are employed in the context of the Canadian dairy processing sector.

C H A P T E R 3

D A T A C O L L E C T I O N

Data collection methods

The study involved two main phases of data collection undertaken over the period April 2004 to January 2005 that moved sequentially from qualitative to quantitative. The data collection took as its starting point a review of the existing literature, in particular research studies on the adoption of traceability in the agri-food system. However, this review found a paucity of previous studies, as demonstrated by the review presented in Chapter 2, and there was great reliance on the first stage of data collection as described below.

The first stage of data collection involved a series (n=6) of in-depth interviews with quality assurance managers at dairy processing facilities in Ontario and Manitoba. Respondents were chosen according to convenience and to maximise the variance within the sample to identify the full range of issues faced by dairy processing facilities. The interviews followed a standard semi-structured guide that ensured consistency across interviewers and between individual interviews. The guide was designed on the basis of the review of literature.

Each interview was audio recorded and transcribed to aid analysis. The primary focus of these interviews was on identifying issues that were then addressed in stage two of the data collection and, therefore, the transcripts were not subject to full and in-dept qualitative data analysis. Rather, two members of the research team independently scanned the transcriptions for key themes under the headings of: 1) motivations to adopt food safety and quality metasystems in general and traceability in particular; 2) costs and benefits of adopting food safety and quality metasystems in general and traceability in particular; and 3) problems and constraints faced when adopting food safety and quality metasystems in general and traceability in particular. The results of this analysis formed the major input to the design of the second stage of data collection.

The second stage of data collection involved a postal survey (n=408) of dairy processing facilities across Canada (Table 1). The sample included all facilities that were either federally-registered or provincially-licensed as of April 2004. The actual number of dairy processing plants in 2002 according to the Annual Survey of Manufacturers was 436, suggesting that the list utilised for the survey included 93.6 percent of all facilities nationwide. The names and addresses of these facilities were provided by Agriculture and Agri-Food Canada (AAFC). Subsequently, the specific name of the quality assurance manager at each facility, to whom the survey was addressed, was solicited by telephone call.

The survey took the form of a structured questionnaire (Appendix A). The questionnaire was initially designed on the basis of the analysis of the in-depth interviews and review of literature. It was subsequently reviewed by AAFC and then tested through a pilot survey (n=10) of dairy processing facilities during September 2004. In the case of Quebec, the questionnaire was translated into French using one round of back-translation. Respondents were also given the option of obtaining the questionnaire in English. The main round of data collection commenced in October 2004 and was completed in January 2005. During this time, two reminders were sent to prospective respondents, the second of which included a new copy of the questionnaire.

The questionnaire included a number of open-ended items. Following entry and cleaning of the data, a list of responses for each of the questions was collated. Categories were then defined from the responses by two members of the research team independently, from which a common series of categories was defined. Individual responses were then allocated to these categories, with a second member of the research team independently coding a sample of responses and discussing discrepancies with the primary coder until a level of inter-coder reliability of 80 percent was obtained. The cleaned and coded data were analysed using SPSS 11.0.

Number and characteristics of respondents

Of the initial mailing to 408 dairy processing facilities, 386 were successfully delivered (Table 1). The number of surveys returned fully completed was 130, representing a response rate of 33.7 percent. The list of federally-registered and provincially-licensed facilities included some plants that did not undertake processing, but rather were only storage facilities for which the survey was not appropriate. It is not possible to estimate the number of these facilities, but the implication is that the real response is greater than 33.7 percent.

Table 1: Number of survey respondents

Category	Number
Sent	408
Returned undelivered	22
Delivered	386
Returned completed	130 (33.7%)

The relative proportion of plants in the sample by province was broadly in line with the geographical distribution of federally-registered and provincially-licensed plants (Table 2). The one exception, however, was Quebec that was significantly under-represented in the sample.

Table 2: Province in which respondent plant situated

Province	Number			
	Sent		Respondents	
Ontario	111	(25.7%)	42	(32.3%)
Quebec	175	(43.3)	45	(34.6%)
Manitoba	12	(3.0%)	3	(2.3%)
Alberta	26	(6.4%)	11	(8.5%)
British Columbia	45	(11.1%)	17	(13.0%)
New Brunswick	11	(2.7%)	3	(2.3%)
Nova Scotia	14	(3.5%)	6	(4.6%)
Prince Edward Island	10	(2.5%)	3	(2.3%)
Total	404		130	

The vast majority (93.8%) of the respondents had their headquarters in Canada, with most of the remainder (4.6%) being owned by businesses from the US. In 56.2 percent of cases, the plant was operated by a business that only operated a single processing facility. The number of employees within the plants ranged from one to 610, with a mean of 49.3 (Table 3). The mean number of employees across the dairy processing sector as a whole, according to the Annual Survey of Manufacturers (2002) is 44.8, suggesting that the sample was slightly skewed towards larger plants. This is despite the fact that one of the major dairy processing companies in Canada that operates a number of large plants declined to participate in the study.

Table 3: Number of respondents by number of employees

Number of Employees	Frequency	
Under 5	29	(22.3%)
5 to 9	25	(19.2%)
10 to 24	20	(15.4%)
25 to 49	22	(16.9%)
50 to 99	16	(12.3%)
100 or more	18	(13.8%)

The value of sales in the previous fiscal year ranged from less than $500,000 to over $25 million (Table 4). The majority (53.1%) was in the range $501,000 to $10 million (Table 3). The mean value of sales per plant according to the Annual Survey of Manufacturers (2002) is $25.8 million, suggesting that the sample was skewed towards plants with a lower turnover.

Table 4: Number of respondents by total revenue of plant in last fiscal year

Revenue	Frequency
Less $500,000 (1)	24 (21.2%)
$501,000 to $1,000,000 (2)	12 (10.6%)
$1,000,001 to $5,000,000 (3)	36 (31.9%)
$5,000,001 to $10,000,000 (4)	12 (10.6%)
$10,000,001 to $25,000,000 (5)	11 (9.7%)
Greater $25,000,000 (6)	18 (15.9%)

Note: Numbers in parentheses are the codes for each revenue category

Around 44 percent of the respondents produced only one type of dairy product, most frequently cheese, fluid milk or ice cream. Only 29.1 percent produced more than two types of dairy products. The products most frequently manufactured were speciality cheeses, yogurt and ice cream and cheddar and processed cheese (Table 5).

Table 5: Dairy products manufactured by respondent plants

Product	Frequency	
Fluid milk/cream/milk beverages	36	
Cheddar & processed cheese		(47%)
Speciality cheese	50	(38.5%)
Yogurt & ice cream	45	(34.6%)
Sour cream & table spreads	19	(14.6%)
Butter & milk powders	36	(27.7%)
Other	15	(11.5%)

The majority (67.7%) of the respondent plants manufactured products with at least one 'speciality' characteristic. The most common were antibiotic-free products, goat milk products, organic products and no preservatives (Table 6); products for which traceability would be an asset in confirming the product characteristics. Around 32 percent manufactured products with two or more speciality characteristics.

Table 6: Dairy products with "speciality" characteristics manufactured by respondent plants

Characteristic	Frequency
Soy milk & products	3 (2.3%)
Goat milk & products	35 (26.9%)
Organic products	29 (22.5%
Lactose-reduced or lactose-free milk & products	3 (2.3%)
GMO-free-products	22 (16.9%)
BST/hormone-free products	27 (20.9%)
Antibiotic-free products	43 (33.1%)
Allergen-free products	8 (6.2%)
Gluten-free products	11 (8.5%)
No preservatives	35 (26.9%)
Produced from unpasteurised milk	27 (20.8%)
Kosher products	4 (3.1%)
Other	18 (13.8%)

The vast majority of the plants in the survey only served Canadian markets, and in particular the province in which they were situated, which accounted for around 71 percent of sales revenue (Table 7). Only 12 percent exported to the US, while nine percent exported to Mexico and/or other overseas markets. Exports only accounted for 4.4 percent of sales revenue on average.

Table 7: Plant sales revenue by market location of respondent plants

Market	Number Serving Market	Mean % Sales Revenue
Within province	124 (95.3%)	70.9%
Rest of Canada	82 (63.1%)	22.2%
US	16 (12.3%)	3.0%
Mexico	3 (2.3%)	0.1%
Other overseas markets	8 (6.1%)	1.3%

The majority of the sales revenue of the surveyed plants was derived from products sold under the company's own name to the final consumer (Table 8). Although 53 percent of plants supplied products that were sold under a food retailer's or food service operator's brand name, on average this only accounted for 18 percent of sales revenue. Around 45 percent sold bulk products to wholesales, processors and/or retailers, although these typically only accounted for 13 percent of sales revenue.

Table 8: Plant sales revenue by branding of products of respondent plants

Market	Frequency	Mean % Sales Revenue
Company brand name to final consumer	119 (91.5%)	65.4%
Food retailer or food service operator brand name	69 (53.1%)	18.2%
Bulk to wholesaler, processor, retailer etc.	59 (45.4%)	13.0%
Other	2 (1.5%)	0.2%

The surveyed dairy processing plants supplied a wide range of customers, the most important of which were other food retailers (for example small grocery outlets) and major supermarket chains that accounted for 25 percent and 17 percent of sales revenue on average and were supplied by more than half of the sample (Table 9). Around 42 percent of the plants supplied wholesalers, which accounted for 17 percent of sales revenue. Although 41 percent sold products direct to the final consumers, this typically accounted for only 11 percent of sales revenue.

Table 9: Plant sales revenue by customer type of respondent plants

Market	Frequency	Mean % Sales Revenue
Non-food retailers	18 (13.8%)	1.1%
Supermarket chains	70 (53.8%)	24.8%
Other food retailers	78 (60.0%)	17.1%
Food service chains	31 (23.8%)	5.2%
Other food service operators	30 (23.1%)	6.0%
Wholesalers	55 (42.3%)	17.2%
Direct to final consumer	53 (40.8%)	11.3%
Other food processors	30 (23.1%)	4.9%
Institutions	23 (17.7%)	2.5%
Other	9 (6.9%)	1.2%

Having outlined the firm and product-level characteristics of the respondents to the survey, the next chapter describes the substantive results of the survey related to the level and nature of adoption of food safety and quality practices.

Data analysis

The survey data were analysed statistically using SPSS. For each of the multi-item scales, means were calculated; with the statistical significance of differences in means tested using the Wilcoxon sign rank test.

In order to understand better the motivations behind the implementation of traceability in the surveyed plants, the range of 20 motivators identified through the case studies and review of literature (see Table 20) were subject to Principle Components Analysis (PCA).[4] In reality, there are likely to be a more narrow range of broader motivators that cut across these 20 motivating factors and reflect fundamental drives to implement product traceability. PCA is a statistical technique through which these can be identified.

Having undertaken PCA, a total of three factors had eigenvalues exceeding one and collectively accounted for 82.2 per cent of the variance in importance scores across the 19 motivators. Loadings were derived for each of these factors using a varimax rotation

To identify the most appropriate classification of respondents, iterative cluster analysis was undertaken.[5] Cluster analysis allows the individual respondents to the survey to be grouped together according to how heavily they load on to each of the broad factors identified above using PCA. For this purpose k-means clustering was employed with progressively increasing cluster values from two to six. The optimal solution was selected on the basis of the maximum value of *kappa*, the corrected coefficient of agreement. The two, three, four, five and six cluster solutions produced *kappa* values of 0.75, 0.91, 0.84, 0.72 and 0.67 respectively. Thus, the three-cluster solution had the greatest internal consistency and was chosen as the most appropriate grouping of respondents.

4. *For more details of principle components analysis see Hair et al. (1998) and Kline (1994).*

5. *For further details on cluster analysis, see for example Hair et al. (1995) and Punj and Stewart (1983).*

CHAPTER 4

ADOPTION OF FOOD SAFETY AND QUALITY PRACTICES

Before exploring the adoption of product traceability systems in depth, respondents were asked about their wider food safety and/or quality practices, including HACCP and GMP. In total 97 (71.7%) of respondents had heard of the Canadian Food Inspection Agency's (CFIA) Food Safety Enhancement Program (FSEP), a HACCP-based food safety system according to which dairy processing plants can be recognised by the CFIA.[6] According to the CFIA, as of January 2004, 57 dairy processing plants were FSEP-recognised, with the highest penetration in western Canada (25.0%) and Ontario (18.9%) and the lowest penetration in Quebec (8.0%).

Although only 38 percent of respondents had actually implemented HACCP, 55 percent were in the process of implementing HACCP or had plans to do so (Table 10). Less then eight percent of respondents had no plans to implement HACCP. However, 49.2 percent had implemented some other food safety system, of which the most common were GMP (14.8%), CFIA standards (5.2%), provincial standards (5.2%) and organic standards (3.5%).

Table 10: HACCP status of respondent plants

Status	Frequency
Fully implemented	49 (37.7%)
Implementing/Plan to implement	71 (54.6%)
No plans to implement	10 (7.7%)

Respondents were asked to rank a series of eight factors in terms of their importance in the decision to implement food safety systems such as HACCP and GMP. Thus, a rank of one indicated that factor considered of most importance and a rank of eight that factor considered of least importance. These factors were derived through analysis of the first stage in-depth interviews with quality assurance managers at dairy processing plants. The factors judged most important on the basis of the mean rank score were meeting customer requirements, improving company image and anticipating regulatory requirements (Table 11). Increasing, the share of existing markets, reducing production costs and, in particular obtaining higher prices, were unimportant.

6. *There are currently plans to make FSEP mandatory for meat processing facilities, although no such proposals have been promulgated for dairy processing plants.*

A significant number (43.8%) of plants required their suppliers of milk and other raw materials to follow food safety guidelines over and above federal and/or provincial regulatory requirements. Most frequently, these guidelines were microbiological and other tests (13.1%), GMP (9.2%) and HACCP (6.9%). A range of tests were routinely undertaken on milk entering the plants in most plants including visual assessment, smell and temperature (Table 12). Microbiological tests and analysis for antibiotic residues were also undertaken in the majority of plants.

Table 11: Mean rank score of factors motivating food safety systems such as HACCP and GMP

Factor	Mean Rank Score
Meeting customer requirements	2.82
Improving the company's image	3.10
Anticipating regulatory requirements	3.48
Reducing recall costs	4.02
Accessing new markets	4.25
Increasing the share of existing markets	4.63[a]
Reducing production costs	4.64[a]
Obtaining higher prices	6.38

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

With regard to food quality, only five (3.8%) of the plants were certified to ISO9000, while a further 15 plants (11.5%) were in the process of implementing ISO9000, or had plans to do so. Other food quality systems and/or programs had been implemented in 38.5 percent of plants, of which the most common were GMP (21.5%) and the company's own system of quality management (14.6%). A further 18.5 percent of plants were planning to implement other food quality program and/or systems.

Table 12: Test undertaken on milk entering the plant

Test	Frequency
Microbiological6	6 (50.7%)
Visual	115 (88.5%)
Smell	113 (86.9%
Temperature	109 (83.8%)
Antibiotic residues	68 (52.3%)
Composition	26 (20.0%)
Acidity/Ph	18 (13.8%)
Other	6 (4.6%)

Respondents were asked to rank the same series of eight factors as above in terms of their importance in the decision to implement food quality systems. Again, a rank of one indicated that factor considered of most importance and a rank of eight that factor considered of least importance. The factors considered most important on the basis of the mean rank scores were meeting customer requirements, improving the company's image, reducing recall costs and accessing new markets (Table 13). Obtaining higher prices was considered a relatively unimportant factor by most respondents.

Among the respondent plants, 27.7 percent required their milk and/or other suppliers to follow certain food quality guidelines over and above federal and/or provincial regulations. Most frequently, these were compositional standards (16.9%).

The majority (63.1%) of plants were required to have their food safety and/or quality systems inspected and/or audited by their customers. Of these, 77.1 percent were subject to inspections/audits by a third party and 57.8 percent by their customers. Plant inspections/audits were generally undertaken either every six months (54.1%) or annually (41.3%). The vast majority (82.3%) of plants also undertook their own internal audits of their food safety and/or quality systems, of these either every six months (59.8%) or annually (37.0%).

Table 13: Mean rank score of factors motivating implementation of food quality systems

Factor	Mean Rank Score
Meeting customer requirements	3.20
Improving the company's image	3.51
Reducing recall costs	3.92a
Accessing new markets	3.97a
Reducing production costs	4.20
Increasing share of existing markets	4.64b
Anticipating regulatory requirements	4.65b
Obtaining higher prices	6.25

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

Examining these results as a whole, it is evident that the dairy processing sector sub-divides into two relatively distinct groups. The first of these had implemented HACCP, GMP and/or other food safety/quality systems, while the second largely operated with more informal systems of food safety/quality control. The relatively small sample size makes it difficult to compare and contrast the characteristics of these two groups. However, it is evident that the food safety/quality system adopters were generally larger plants; the mean number of employees of plants in the first group was 95.8, compared to 21.1 for the second group (Table 14). They also had higher mean sales revenue. Supermarkets also accounted for a greater proportion of the sales revenue within the adopter group. The adopters derived a greater proportion of their sales revenue from markets outside of their home province.

Table 14: Characteristics of adopters and non-adopters of HACCP

Characteristics	HACCP Adopters	HACCP Non-Adopters
Number of employees	95.8%	21.1%
Sales revenue from outside province	24.4%	20.9%
Sales revenue from US	4.0%	2.5%
Sales revenue from supermarkets	29.6%	21.9%
Value of sales revenue	3.54%	2.78%

Note: Mean score for sales revenue based on the categories in Table 3.4.

Having explored the adoption of food safety and/or quality systems in general, the remainder of the report now focuses on the implementation of product traceability in particular. The next chapter starts by describing the degree to which product traceability has been implemented in the dairy processing sector and the specific characteristics of these systems. It then proceeds to explore the factors motivating adoption, the associated firm-level costs and benefits and the problems encountered during and after implementation.

CHAPTER 5

ADOPTION OF PRODUCT TRACE-ABILITY

This chapter now examines in some depth, the level and nature of adoption of product traceability systems within the dairy processing sector. In particular, it considers the factors motivating adoption of traceability systems and the associated costs and benefits.

Nature of product traceability systems

Almost 91 percent of the respondents to the survey had implemented a system of product traceability (Table 15). Around 89 percent was able to track fully their products forwards to the level of retail distribution, while 79 percent could trace their inputs back to named individual or groups of farmers. The majority (67.5%) had implemented their system of product traceability more than four years ago (Table 16), with only 12 percent having implemented traceability systems within the last two years.

Table 15: Level of product traceability in respondent plants

Level of Traceability	Frequency
Traceability system in place	118 (90.8%)
Forwards traceability:	
- Through to retail distribution	105 (89.0%)
- Only to next level of supply chain	13 (11.0%)
Backwards traceability:	
- Named individual or groups of farmers	93 (78.6%)
No traceability system planned	12 (9.2%)

The maximum precision of traceability in most plants (89.6%) that had adopted a product traceability system was an individual days production (Table 17). However, 48 percent could trace to multiple batches within a single days production or individual product units. A total of 95.7 percent of plants could trace back at least 90 percent of their production to this maximum level, while 82.1 percent could trace back all of their production to this level.

Table 16: Years traceability system had been operational in plants with system in place

Years	Frequency
1 to 2 years	14 (12.0%)
3 to 4 years	24 (20.5%)
5 to 6 years	26 (22.2%)
7 to 8 years	17 (14.5%)
9 to 10 years	10 (8.5%)
11 to 15 years	16 (13.7%)
16 years or more	10 (8.5%)

The focus of most of the systems of product traceability implemented by survey respondents was general product safety rather than specific product attributes (Table 18). However, a significant minority did trace specific attributes, most frequently antibiotic-free, unpasteurised and organic. In 66.1 percent of cases the traceability system was manual. Of the 33.9 percent of plants that had implemented a computer/electronic system, 52.5 percent had purchased or developed specific software for the purpose. This suggests that the systems of traceability implemented across most respondents were relatively 'unsophisticated', probably taking the form of simple systems of record-keeping with respect to input supplies, production and product lots.:

Table 17: Smallest unit of product traceability in respondent plants

Level of Traceability	Frequency
Four or more day's production	5 (4.3%)
Two or three days production	1 (0.9%)
Individual days production	49 (41.9%)
Multiple batches within single day's production/ Individual product units	62 (47.7%)

Although the limited sample size makes it difficult to draw reliable comparisons between plants that had implemented computer-based systems of traceability as opposed to manual systems, some differences are evident. Thus, the mean size of plants with a computer-based system (84.8 employees) was significantly greater than plants with a manual system (37 employees). Plants with a manual system of traceability derived a greater proportion of their sales revenue from within their own province and a marginally smaller proportion of their sales revenue from products that were sold under a food retailer and/or food service operator's brand name. The typical plant with a computerised traceability system had sales revenue in the range $5 to 10 million, while plants with a manual system typically had sales revenue in the range $1 to 5 million.

Table 18: Frequency of specific product attributes being traced by plants with a traceability system in place

Attribute	Frequency
General product safety	81.7%
Antibiotic-free	45.9%
Unpasteurised	30.3%
Organic	29.4%
Allergen-free	19.3%
No preservatives	16.5%
Environmentally-sustainable process	15.6%
Non-GMO	12.8%
BST-free	9.2%
Lactose-free	5.5%
Other	3.0%

Around 77 percent of plants undertook periodic tests of their product traceability system, most frequently on a six month or annual basis (Table 19). Of the plants with a traceability system, 64.1 percent had had the efficacy of their system verified through an external audit.

Table 19: Frequency of testing of traceability system

Years	Frequency
Undertake periodic tests	91 (77.1%)
Frequency of tests:	
- Weekly	9.9%
- Monthly	14.3%
- Every 3 months	6.6%
- Every 6 months	25.3%
- Annually	42.9%
Do not undertake tests	27 (22.9%)

Almost a quarter (23.1%) of plants that had implemented a system of product traceability had experienced a product recall and/or withdrawal in the three years prior to implementation. Of these, 15 (71.4%) had experienced only one recall, while six (28.6%) had experienced two recalls. A greater proportion of these plants (35.0%) had experienced a product recall and/or withdrawal since implementing their traceability system. Of these, 27 (75.0%) had experienced one recall, while nine (25.0%) had undergone two or more recalls. Whether, this relatively high rate of recalls reflects a greater attentiveness to food safety and/or quality issues as a result of implementing traceability is beyond the scope of the current study. Likewise, it is not possible to say whether the costs associated with these recalls had diminished as a result of implementing a traceability system.

Motivation to implement a product traceability system

To determine and assess the motivating factors behind the implementation of product traceability systems, respondents were presented with a series of 19 potential motivators identified through analysis of the in-depth interviews with quality assurance managers in dairy processing plants during stage one of the data collection. They were asked to score the importance of each in the decision to implement their system of traceability on a five-point Likert scale from ‘very important (5) to ‘very unimportant’ (1). The factors considered most important for the sample as a whole were reducing the risk of a product problem occurring, reducing the impact when a product recall occurs, reducing product liability and meeting current regulatory requirements (Table 20). Repositioning products and/or increasing share of current markets, reducing costs of production/enhancing yields and obtaining higher prices for products were considered of least importance in the decision to implement product traceability.

The factors presented to respondents as detailed in Table 20 represented the range of motivators for firms to implement product traceability as identified through the case studies and review of literature. In reality, however, there are likely to be a more narrow range of broader motivators that cut across these factors and reflect fundamental drives to implement product traceability. These broader motivators were identified using a technique called principle components analysis (PCA) (see Chapter 3).

Table 20: Importance of factors influencing decision to implement a system of product traceability

Factor	Mean Score
To reduce the risk of a product problem occurring	4.79
To reduce the impact when a product recall occurs	4.69
To reduce product liability	4.46[a]
To meet current regulatory requirements	4.45 [a]
Reduce risk of product recalls	4.43 [a]
So I can worry less about a product recall occurring	4.31[b]
I think it is good practice	4.29[b]
To meet current customer requirements	4.16[c]
To meet anticipated future regulatory requirements	4.15[c]
To meet anticipated future customer requirements	4.04[d]
Reduce customer complaints	4.03[d]
Improve inventory management	4.00[d]
Reduce spoilage or improved freshness	3.99[d]
Improve coordination of supply chain	3.72
Access new markets	3.57[e]
Recommended by trade/industry organization	3.56[e]
Reduce costs of production/improved yield	3.45[f]
Increase share of current markets	3.43[f]
Reposition products in current markets	3.28
Obtain higher price for products	3.09

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

A total of three factors were identified using PCA that collectively accounted for 82.2 per cent of the variance in importance scores across the 20 motivators. Loadings for each of these factors are presented in Table 21. On the basis of these loadings, the three factors can be interpreted as follows:

- **Factor 1:** Overall, this factor represents **product problems** as a driver for the adoption of product traceability in dairy processing plants. This factor has heavy loadings for reduce risk of product recalls, reduce customer complaints, reduce the risk of a product problem occurring and reducing the impact when a product recall does occur.

- **Factor 2:** Overall, this factor is associated with **market drivers** for the implementation of product traceability. The motivators that loaded most heavily on this factor included meeting current customer requirements, reducing customer complaints, improving coordination of the supply and inventory management, increasing share and repositioning products in current markets and obtaining higher prices for products.

- **Factor 3**: This factor represents **legal requirements**, including direct regulation and liability, as a driver of product traceability. The dominant motivators in this factor are meeting current regulatory requirements, reduce product liability and recommended by trade/industry organization.

Table 21: Principal components analysis of motivators to implement a system of product traceability

Variable	Factor 1	Factor 2	Factor 3
To reduce the risk of a product problem occurring	0.654	0.137	0.543
To reduce the impact when a product recall occurs	0.641	0.321	0.362
To reduce product liability	0.064	0.205	0.732
To meet current regulatory requirements	0.301	0.086	0.683
Reduce risk of product recalls	0.727	0.231	0.383
So I can worry less about a product recall occurring	0.702	0.104	0.174
I think it is good practice	0.402	0.093	0.153
To meet current customer requirements	0.273	0.676	0.073
To meet anticipated future customer requirements	0.074	0.376	0.152
Reduce customer complaints	0.691	0.743	0.295
Improve inventory management	0.153	0.671	0.015
Reduce spoilage or improved freshness	0.485	0.286	0.164
Improve coordination of supply chain	0.053	0.691	0.095
Access new markets	0.127	0.743	0.132
Recommended by trade/industry organization	0.045	0.294	0.629
Reduce costs of production or improved yield	0.302	0.282	0.074
Increase share of current markets	0.083	0.721	0.037
Reposition products in current markets	0.126	0.764	0.139
Obtain higher price for products	0.029	0.693	0.059
% variance	38.4%	25.5%	18.3%

This approach illustrates how the adoption of product traceability systems in the dairy processing sector is motivated by three major drivers that relate to market demands and requirements, the need to manage the risks associated with product recalls and customer complaints and broad legal requirements. Of these, product problems dominated, alone accounting for 38.4 percent of the variance within the sample. At the same time, however, it is evident from the variation in importance scores attached to these 19 motivators across respondents and analysis of the first stage in-depth interviews that the reasons for adopting product traceability differed between processing facilities according to a range of market and firm-level characteristics. Thus, to identify systematic similarities/differences in the motivation to adopt product traceability, respondents were clustered according to their loadings on each of these three factors.

To identify the most appropriate classification of respondents, iterative cluster analysis was undertaken (see Chapter 3). This identified three clusters of plants across the sample as a whole (Table 22). The factor scores and size of each of the three clusters are described in Table 22. Factor scores have a mean of zero and standard deviation of one. A negative value indicates below average activity and a positive value above average activity on a particular factor. Based on the cluster means for the derived factor scores and the cluster sizes, the following descriptors were derived:

- **Cluster 1:** The largest cluster, accounting for 51 percent of respondents, can be classified as driven by **risk management** associated with product problems related to recalls and customer complaints in particular, but also meeting regulatory requirements and managing product liability. Market drivers were less important than for respondents as a whole.
- **Cluster 2:** Around 27 percent of respondents can be classified as **market driven**, for which market drivers are more important and legal requirements and product recall less important than for respondents as a whole.
- **Cluster 3:** This cluster, accounting for 22 percent of respondents, is associated with **multiple drivers**. The plants in this cluster were simultaneously driven by all three broad motivating factors to implement product traceability, although with greater emphasis on legal requirements and product liability than market drivers.:

Table 22: Cluster means for factor scores derived from K-means clustering

Factor	Cluster 1	Cluster 2	Cluster 3
1. Product problems	1.345	-1.967	0.945
2. Market drivers	-1.743	1.432	0.663
3. Legal requirements	0.341	-2.290	1.056
Proportion of respondents	50.8%	26.9%	22.3%

Having identified three distinct clusters of firm according to the motivation to adopt product traceability systems, the characteristics of respondents was examined to identify whether certain types of plants/firms belonged to particular clusters. There was significant variation across the clusters for three of the main characteristics examined. Table 23 presents the key differences across the clusters, namely the mean number of employees, branding of final products and relative importance of customer types. The associated chi-squared and significance levels are given in the tables.

The characteristics of the respondents belonging to each cluster provide an external validation of the defined clusters and the associated interpretations described above. Cluster 1, which was characterised as driven by risk management, consisted of plants that were around the mean size in terms of number of employees and sold a large proportion of their products under their own brand name. Other food retailers accounted for a significant proportion of their total sales compared to other groups. Firms in Cluster 2 implemented product traceability predominantly because of market drivers. These firms sold a greater proportion of their products to the major supermarkets and products manufactured under a retailer and/or food service operator's brand name were relatively more important. Finally, Cluster 3, which was driven by multiple motivators to implement a product traceability system, consisted of the smallest plants and sold the greatest proportion of their output to other retailers and wholesalers under its own brand name. Sales to the major supermarkets were more important than for Cluster 1.

Table 23: Distinguishing characteristics of cluster members

	Characteristic	Risk Management	Market Drivers	Multiple Motives	χ^2	
Mean number of employees		47.6	80.6	26.4	19.3	(0.01)
Brand (% sales)	Company brand	65.6%	51.0%	70.3%	17.3	(0.05)
	Retailer brand	17.1%	26.5%	12.8%	10.5	(0.01)
	Bulk	14.6%	21.0%	16.9%	12.6	(0.05)
Customer (% sales)	Major supermarket	20.2%	37.7%	25.4%	13.4	(0.01)
	Other food retailers	37.3%	18.4%	26.7%	8.7	(0.01)
	Wholesalers	17.6%	3.2%	20.5%	10.3	(0.01)
	Direct to consumers	6.4%	13.5%	15.4%	5.4	(0.05)

Note: Figures in parentheses are significance levels.

The survey also included a scaling task related to the reasons why processing facilities had not implemented a system of product traceability. However, the number of respondents (12) in this category was too small to permit any meaningful analysis and, consequently, these results are not reported here.

Problems experienced with product traceability systems

Having identified the motivators for respondents to implement systems of product traceability in their facility, an attempt was made to identify the problems that had been faced in the process of implementation, maintenance and/or operation of such systems. First, respondents were presented with a series of potential problems that had been identified through analysis of the stage one in-depth interviews. They were asked to score each of these on a five-point Likert scale from 'very important' (5) to 'very unimportant' (1) according to experiences in their own processing facility.

The predominant problems associated with implementing, maintaining and/or operating a product traceability system as identified by the survey respondents were associated with staff, in particular those involved in production/supervision (Table 24). The highest mean importance score was attached to the attitude/motivation of production/supervisory staff, the need to retrain production/supervisory staff, the attitude/motivation of managerial/administrative staff and the need to retrain managerial/administrative staff. Support and cooperation of customers was also considered important. The least important problems were the development and availability of appropriate software, and availability of reliable consultants.

Table 24: Significance of problems in implementing, maintaining and/or operating a traceability system

Factor	Mean Score
Attitude/motivation of production/supervisory staff	4.20[a]
Need to retrain production/supervisory staf	4.19[a]
Attitude/motivation of managerial/administration staff	4.00
Need to retrain managerial/administration staff	3.79[b]
Support and co-operation of customers	3.76[b]
Support and co-operation of suppliers	3.62[c]
Number of product attributes/processes to be recorded	3.59[c]
Flexibility of production processes	3.45[d]
Lack of clear standards for traceability systems	3.44[d]
Ability to manufacture new products	3.24
Takes production/supervisory staff away from other duties	3.08[e]
Takes management/administrative staff away from other duties	3.06[e]
Availability of reliable consultants	2.89
Development and availability of appropriate software	2.72

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

To provide alternative measures of the problems associated with the implementation, maintenance and operation of systems of product traceability in dairy processing and a means to provide some assessment of the validity of response to the scaling question, respondents were also asked to identify the impediments they had faced in achieving traceability through to retail or food service distribution. In so doing, they were asked to distinguish between impediments that were internal to their plant/company and those that were external.

Table 25: Unprompted impediments to achieving traceability of products through to retail or food service distribution

Factor	Mean Score
Internal to Plant/Company	
Staff motivation	28 (23.7%)
Reliable record-keeping	21 (17.8%)
Human error	16 (11.0%)
Coordination of tasks	11 (9.3%)
Other staffing issues	8 (6.8%)
Training	6 (5.1%)
External to Plant/Company	
Lack of customer cooperation	27 (22.9%)
Poor flow of information	16 (13.6%)
Human error	8 (6.8%)
Removal of labels	7 (5.9%)
Variation in traceability systems	7 (5.9%)

Internal impediments most frequently cited unprompted by respondents were staff motivation, record-keeping and human error, all of which relate to staffing issues and broadly concur with the responses to the scaling question (Table 25). In the case of impediments that are external to the plant/company, the most frequently cited issues were lack of customer cooperation and the poor flow of information between the supplier and customer. Related issues include the removal of labels containing traceability information by customers and the incompatibility of traceability systems between customers and their suppliers.

Costs and benefits associated with product traceability system

The survey enabled the various elements of the potential costs and benefits associated with the implementation of product traceability to be explored. Each is now described in turn below.

Reconfiguration of production systems and personnel

Before proceeding to examine the specific costs and benefits associated with the implementation, maintenance and operation of product traceability systems in diary processing, respondents were asked to consider the extent to which production system and/or personnel duties/responsibilities had needed to be reconfigured in their own plant. While more than 70 percent of respondents indicated that the implementation of their product traceability system had required some readjustment of production and/or personnel duties/responsibilities, in the majority of cases these were minor (Table 26). Indeed, only 10 percent of plants had been required to undertake significant reconfiguration of their production systems, while 14 percent had made major changes to personnel duties and/or responsibilities.

Table 26: Reconfiguration of production system and personnel duties/ responsibilities when implementing a traceability system

Nature	None		Minor		Major	
Production system	30	(27.8%)	72	(62.6%)	11	(9.6%)
Personnel duties/responsibilities	29	(22.3%)	69	(53.1%)	18	(13.8%)

Cost of Implementation

To identify the non-recurring and recurring costs associated with systems of product traceability, respondents were presented with a series of potential areas in which costs might be incurred. They were asked to score each of these on a five-point Likert scale from 'very important' (5) to 'very unimportant' (1) according to experiences in their own processing facility, first when implementing their system of product traceability and second when maintaining and operating this system.

The most important costs incurred when implementing systems of product traceability were inspections/audits, laboratory testing and the time of supervisors, production workers and managerial/administrative staff (Table 27). This broadly concurs with the analysis of the in-depth interviews, which indicated the quite considerable expenditures incurred by processing plants to test the performance of their traceability system and have it verified by an external agency. At the same time, these costs were highly visible, in that payments were often made to an external supplier, especially in comparison with staff costs that largely took the form of opportunity costs rather than additional financial outlays. External consultants and the purchase of software were generally considered unimportant, reflecting the fact that a relatively small proportion actually purchased or developed software as part of the implementation of their traceability system.:

Table 27: Importance of costs of implementing system of product traceability

Cost	Mean Score
Inspections/audits	4.07[a]
Laboratory testing	4.04[a]
Supervisory staff time	3.81[b]
Production line staff time	3.80[b]
Managerial/administrative staff time	3.55[c]
Disruption of production	3.54[c]
Purchase of new equipment	3.35
External training courses	3.15[d]
Renovation of plant	3.13[d]
Purchase of new software	2.97
External consultants	2.80

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

Costs of maintenance/operation

The costs of maintaining and/or operating systems of product traceability were dominated by staff time, in particular of production workers and supervisors (Table 28). Other important costs included the cost of monitoring suppliers and regular inspections/audits. External consultants and on-going training courses were unimportant costs of maintaining and/or operating systems of product traceability.

Table 28: Importance of costs of maintaining and/or operating a system of product traceability

Cost	Mean Score
Production staff time	4.05[a]
Supervisory staff time	4.03[a]
Monitoring suppliers	3.64[b]
Inspections/audits	3.63[b]
Laboratory testing	3.48[c]
Managerial/administrative staff time	3.47[c]
Upgrading equipment	3.46[c]
Upgrading software	3.10
External training courses	2.92[e]
External consultants	2.90[e]

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

Benefits of implementing a traceability system

The majority (71.2%) of plants considered that they had derived at least some benefits from the implementation of their product traceability system that offset, at least in part, the costs they had incurred. To identify the specific benefits that had been derived, respondents were presented with a range of 17 potential impacts of implementing a product traceability system that had been derived from analysis of the in-depth interviews. They were asked to score each of these on a five-point scale from 'very positive' (+2) to 'very negative' (-2) with a mid-point of 'no change' (0).

Across respondents as a whole, the potential impacts of implementing product traceability were also scored positively, with the two exceptions of inventory costs and production costs that were considered marginally negative (Table 29). On the basis of mean scores, the main benefits of product traceability were considered to be the way in which the company was perceived by commercial customers and/or regulators and the ability to meet customers and/or regulatory requirements. All of these benefits are rather intangible in nature compared to, for example, impacts on product prices and number of recalls. These were considered less significant benefits of implementing a system of product traceability, despite the fact that these had been predominant motivators for many plants to implement a system of traceability in the first place. This reflects the fact, perhaps, that most plants had only implemented a manual traceability system that is less likely to yield significant benefits in terms of proactive management and coordination of food products.

Table 29: Impact of traceability system on company performance

Impact	Mean Score
How company perceived by commercial customers	1.19[a]
How company perceived by regulators	1.18[a]
Ability to meet customer requirements	0.96[b]
Ability to meet regulatory requirements	0.95[b]
How company perceived by consumers	0.81[c]
Scope of product recalls/withdrawals	0.78[c]
Motivation of managerial/administration staff	0.78[c]
Costs in the event of a product recall/withdrawal	0.65[d]
Number of product recalls/withdrawals	0.64[d]
How company perceived by rest of industry	0.63[d]
Motivation of production/supervisory staff	0.53[e]
Levels of product wastage/reworking	0.51[e]
Ability to increase share of existing markets	0.51[e]
Prices realized for products	0.36[f]
Ability to access new markets	0.36[f]
Inventory costs	0.10
Production costs	-0.07

Note: Mean rank scores with same letter suffix are not significantly different at the five percent level.

The majority (66.4%) of plants had not experienced any change in production costs as a result of implementing a system of product traceability (Table 30). In the cases where production costs had changed, these had most frequently (26.4%) increased. The range of change in production costs across the sample as a whole was -20 percent to 25 percent, with a mean of 4.3 percent.

Table 30: Change in cost of production as a result of implementing a system of product traceability

Impact	Frequency
Decrease	8 (7.3%)
No change	73 (66.4%)
Increase	29 (26.4%)

In total, 60 percent of respondents considered that the benefits of implementing a system of product traceability in their plant had exceeded the costs (Figure 2). Across the sample, 35.5 percent considered that the benefits were much greater than the costs. Only 4.5 percent of respondents considered that the costs they had incurred exceeded the benefits. Broadly, the benefits associated with implementing systems of product traceability were in accordance with prior expectations (Figure 3).

Only 27.8 percent of respondents considered that the benefits of product traceability exceeded expectations. However, 44.3 percent indicated that the costs they had incurred exceeded their *a priori* expectations, most notably those associated with staff time.

Figure 1: Perception of benefits versus costs of implementing traceability system

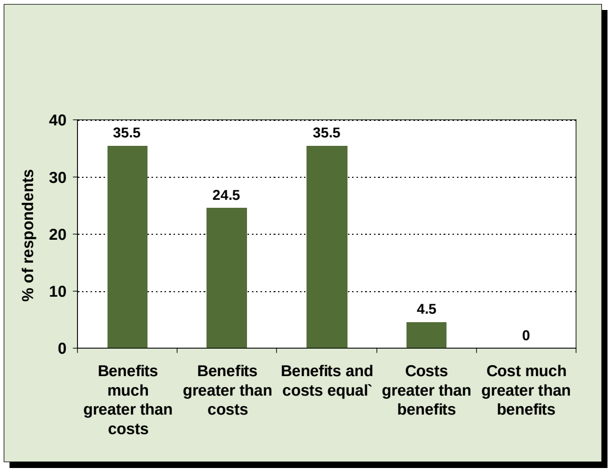
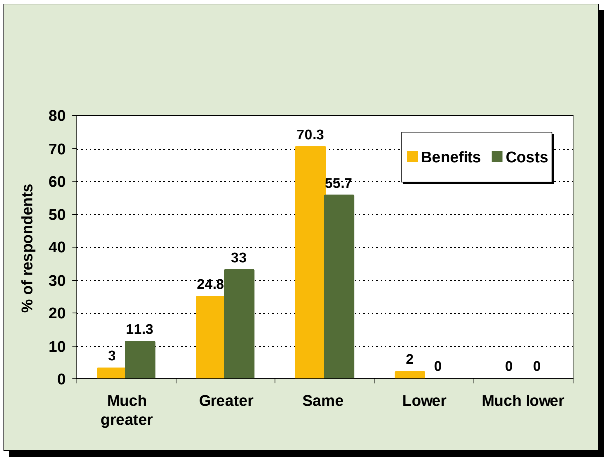


Figure 3: Costs and benefits of implementing traceability systems compared to prior expectations



CHAPTER 6

CONCLUSION

This study has provided the first in-depth insight into the implementation of product traceability systems in the Canadian dairy processing sector. It examines the motivators behind the adoption of product traceability and the associated costs and benefits that have broader relevance to the Canadian food processing sector. Further, the measurement instruments that have been developed could usefully be employed to investigate the nature and level of product traceability in other sectors, facilitating comparison both within and across product sectors, markets, firm size, etc. As each sector has unique structures, opportunities and challenges, extending this analysis across different sectors would allow the development of strategies and policies more accurately tailored to the needs and incentives in each sector.

While HACCP, GMP and other food safety and/or quality systems have been implemented by certain elements of the dairy processing sector, motivated in particular by customer requirements and the desire to enhance the image of the business, these remain the exception rather than the rule. Indeed, the majority of respondents to the survey had not implemented HACCP, for example, although a significant proportion did have plans to do so. Very few facilities had implemented ISO 9000, or indeed had plans to do so. Quality was most frequently managed through more informal systems that had been designed and implemented internally.

In contrast to food safety and/or quality systems in general, product traceability is relatively widespread; indeed only a small minority of respondents to the survey had not implemented a system of product traceability. While this may not provide a perfect measure of the level of adoption within the dairy processing sector as a whole, the focus of the survey on food safety and quality practices more generally was designed to prevent exclusion of non-adopters. Thus, we might reasonably expect that systems of product traceability have been widely implemented across the dairy processing sector. The level of sophistication of the systems is relatively low. Most were manual rather than computer-based systems, although they generally permit traceability to the level of at least one day's production, through to retail distribution and back to single or at least groups of milk producers.

The main motivating factors for implementing product traceability in the dairy processing sector were reductions in the risk of product problems, diminished impacts where recalls occurred and reduced product liability, with gaining access to new markets, higher prices and repositioning in current markets being relatively unimportant. Using principle components analysis, three broad categories of motivators were identified, namely **market drivers** such as customer requirements and enhancement of supply chain coordination, managing the risk and consequences of **product recall** and customer complaints and **legal requirements** including regulations and liability standards. Of these, market drivers were the predominant motivating factor. When the survey respondents were clustered according to these three broad motivators, around half were classified as being driven by the management of risks, related to product recalls, customer complaints and legal requirements. These were generally smaller dairy processing facilities that predominantly sold products under their own brand name through small food retailers. Market drivers were more important for plants that had greater sales to the major supermarkets and/or were more involved in the manufacture of private label products for food retailers or food service operators.

The most prominent problems experienced in implementing, maintaining and/or operating a system of product traceability in the dairy processing sector related to the attitude and motivation of staff and/or the need for retraining. These problems were most commonly associated with production and supervisory staff, but applied to managerial and administrative staff. Maintaining traceability through the supply chain was also hindered by problems with customer cooperation and the flow of information from suppliers to their customers. Lesser problems related to such issues as the removal of labels containing traceability information and/or lack of compatibility of traceability systems.

The major costs of implementing a system of product traceability related to auditing and inspection and laboratory analysis that were generally purchased from external providers, and the opportunity cost of supervisory, production and managerial/administrative staff. These staff costs were also the predominant on-going cost of maintaining and operating a system of product traceability. Relatively few processing facilities had experienced an increase in production costs as a result of implementing product traceability; where production costs had increased, the increase was generally modest. Almost 45 percent of the survey respondents indicated that the costs they had incurred in implementing, maintaining and/or operating product traceability in their plant had exceeded prior expectations. Interestingly, the benefits achieved were not necessarily the ones motivating the adoption of traceability. While the majority of firms were motivated by risk management, four of the five largest impacts noted dealt with consumer, customer and regulator perceptions and the ability to meet customer needs.

The predominant benefits of implementing a system of product traceability were intangible, relating to issues such as perceptions of the company among customers and/or regulators and the ability to meet customer and/or regulatory requirements. More tangible benefits, such as enhanced prices or reduced recalls were considered less significant. Despite the intangible nature of the benefits they had experienced, however, the vast majority of respondents indicated that, as a whole, these were in line with their expectations. This provides a contrast, somewhat, with the limited prior literature (see Chapter 2). The majority also considered that these benefits exceeded the costs of implementing, maintaining and operating their system of product traceability. Only minor or negative impacts were noted in areas related to supply chain management. This can, in part, be explained by the fact that manual implementation of many of the systems limits the information available to decision makers and thus the ability to capture the efficiency-related benefits of tracking products through a supply chain.

These results as a whole suggest that product traceability has been implemented widely in the Canadian dairy processing sector, reflecting a range of motivating factors related to management of the risks associated with product recalls, customer complaints and legal requirements and a broad range of market drivers related to customer requirements, management of the supply chain, etc. The relative importance of these drivers varies according to size of plant and the markets served. Across the sector as a whole, there appear to be good economic and commercial reasons for implementing a system of product traceability; it is widely perceived that there are significant benefits that exceed the costs of implementing, maintaining and/or operating systems of product traceability.

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ID: ____________________

Questionnaire

Department of Agricultural Economics & Business
University of Guelph

Food Safety and Quality Practices in the Canadian Dairy Processing Sector

The Department of Agricultural Economics and Business at the University of Guelph is currently undertaking a study of food safety and quality practices and traceability systems in the Canadian dairy processing sector on behalf of Agriculture and Agri-Food Canada. The aim of this study is to identify the food safety and quality traceability practices adopted by dairy processors across Canada and the factors that are driving these.

As part of this study, a postal survey is being undertaken of all dairy processing plants in Canada. The success of the study depends on the willingness of plants such as yours to participate and we sincerely hope you can find the time to answer the questions below. Below are a few basic instructions which will help you to complete the questionnaire:

- Please answer all of the questions as best you can. An approximate answer is better than no answer at all.
- There are no right or wrong answers. Firms operate under different conditions and may respond in their own particular ways to similar circumstances. The aim of this survey is to understand better these differences.
- Most questions only require single word answers or a check in a box.
- Please feel free to write on the questionnaire if you feel this provides additional information or clarification.
- **A reply-paid envelope has been enclosed for the return of the questionnaire.**

This research is being undertaken in accordance with the ethical procedures of the University of Guelph. All responses to the survey will remain confidential to the study team at University of Guelph. Agriculture and Agri-Food Canada will receive electronic raw data, although your company's name and address will not be disclosed to ensure anonymity. If you have any questions at any time, please do not hesitate to contact the director of the study:

If you have any further questions or queries please do not hesitate to contact us:

Dr. Spencer Henson
Department of Agricultural Economics & Agribusiness
University of Guelph
Guelph, Ontario
N1G 2W1
Telephone: 519-824-4120 (extension 53134)
Email: shenson@uoguelph.ca

We would like to thank you for your valuable contribution to this study.

Questionnaire

General Information

1. How many full time equivalent (FTE) employees do you have at the plant, including yourself, as of June 2004? ____________________

2. Does the company which owns the plant also operate other plants?

   Yes ☐ No ☐

3. Where is the main headquarters of the company?

   Canada ☐
   US ☐
   Europe ☐
   Other (*specify*): ______________ ☐

4. What was the total revenue of the plant in the last fiscal year? *(Please check one)*

   Less than $500,000 ☐ $501,000 - $1,000,000 ☐
   $1,000,001 - $5,000,000 ☐ $5,000,001 - $10,000,000 ☐
   $10,000,001 - $25,000,000 ☐ Greater than $25,000,000 ☐

5. What dairy products are produced in the plant? *(Please check all that apply)*

   Fluid milk/creamed/milk beverage ☐
   Cheese (cheddar and processed) ☐
   Specialty cheese ☐
   Yogurt and ice cream ☐
   Sour cream and table spreads ☐
   Butter, powders and composite milk products ☐
   Other *(specify):* ________________ ☐
   Other (*specify*): ________________ ☐

6. Do you produce any products with the following 'speciality' characteristics? *(Check all that apply)*

   Soy milk and products ☐
   Goat milk ☐
   Organic ☐
   Lactose reduced or lactose free milk ☐
   GMO free ☐
   BST/hormone free ☐
   Antibiotic free ☐
   Allergen free ☐
   Gluten free ☐
   No preservatives ☐
   Produced from unpasteurised milk ☐
   Other (*specify*): ________________________ ☐
   Other (*specify*): ________________________ ☐

Your customers

7. What proportion of the total revenue from the plant is sold to each of the following markets?

Within the province of location	________ %
Rest of Canada	________ %
U.S.	________ %
Mexico	________ %
Other overseas markets	________ %

If you do not sell to markets outside North America proceed directly to Question 9:

8. To which of the following overseas markets do you supply products? *(Please check all that apply)*

European Union	☐
Japan	☐
Central America	☐
China	☐
Other *(specify)*: ____________	☐
Other *(specify)*: ____________	☐

9. What proportion of the total revenue from the plant is sold in the following ways?

Sold under your company's brand name to the final consumer	________ %
Sold under a food retailer or food service operator's brand name	________ %
Sold in bulk to a wholesaler, another food processor, retailer etc.	________ %
Other *(specify)*: ________	________ %
Other *(specify)*: ________	________ %

10. What proportion of the total revenue from the plant is sold to each of the following types of customers?

Non-food retailer (eg. Walmart)	________ %
Supermarket chains (eg. Loblaws)	________ %
Other food retailers (eg. small grocery outlets)	________ %
Food service chains (eg. MacDonalds)	________ %
Other food service operators	________ %
Wholesalers	________ %
Direct to final consumer	________ %
Other food processors	________ %
Institutions (ie. hospitals, universities, etc)	________ %
Other *(specify)*: ________	________ %
Other *(specify)*: ________	________ %

Food Safety Systems

11. Have you heard about the Canadian Food Inspection Agency's (CFIA) voluntary Food Safety Enhancement Program (FSEP)?

Yes ☐ No ☐

12a. Has HACCP been fully implemented in the plant?

Yes ☐ *Proceed to Question 12b*
No ☐ *Proceed to Question 13*

12b. Does your HACCP system cover all of the products produced/handled in the plant?

Yes ☐ No ☐

Proceed directly to Question 14a

13. Are you in the process of implementing, or do you plan to implement, HACCP in the plant?

Yes ☐ No ☐

14a. Have you implemented any other food safety systems or programs in the plant?

Yes ☐ *Proceed to Question 14c*
No ☐ *Proceed to Question 14b*

14b. Do you plan to implement any other food safety programs or systems in the plant?

Yes ☐ *Proceed to Question 14c*
No ☐ *Proceed to Question 15*

14c. Which other food safety programs or systems have you implemented and/or plan to implement?

1. ______________________________
2. ______________________________
3. ______________________________

15. Below are a number of potential reasons for implementing food safety systems such as HACCP and Good Manufacturing Practice in dairy processing plants. Please rank these factors according to their importance in decisions regarding the implementation of such practices in your own plant. *(For those that are non-applicable, put "NA")*

	Rank
Obtaining higher price	____
Reducing production costs	____
Reducing recall costs	____
Improving company image	____
Accessing new markets	____
Increasing share of existing markets	____
Meeting customer requirements	____
Anticipating regulatory requirements	____

16a. Do you require producers/suppliers delivering to your plant to follow certain food safety guidelines over and above federal/provincial regulations? *(Please check one)*

Yes ☐ *Proceed to Question 16b*
No ☐ *Proceed to Question 17*

16b. Which guidelines do you require them to follow? (*Please provide a short description*)

____
____
____
____

17. What tests do you undertake on milk as it enters the plant?

	Yes	**No**
Microbiological	☐	☐
Visual	☐	☐
Smell	☐	☐
Temperature	☐	☐
Other *(specify)*: ____________	☐	☐
Other *(specify)*: ____________	☐	☐

Food Quality Systems

18. Is the plant currently certified to ISO 9000?

Yes ☐ *Proceed to Question 20*
No ☐ *Proceed to Question 19*

19. Are you in the process of implementing, or do you plan to implement, ISO 9000 in the plant?

Yes ☐
No ☐

20a. Have you implemented any other food quality systems or programs in the plant?

Yes ☐ *Proceed to Question 20c*
No ☐ *Proceed to Question 20b*

20b. Do you plan to implement any other food quality programs or systems in the plant?

Yes ☐ *Proceed to Question 20c*
No ☐ *Proceed to Question 21*

20c. Which other food quality programs or systems have you implemented and/or plan to implement?

1. ______________________________
2. ______________________________
3. ______________________________

21. Below are a number of potential reasons for implementing food quality systems such as ISO 9000 in dairy processing plants. Please rank these factors according to their importance in decisions regarding the implementation of such practices in your own plant. *(For those that are non-applicable, put "NA")*

	Rank
Obtaining higher price	_____
Reducing production costs	_____
Reducing recall costs	_____
Improving company image	_____
Accessing new markets	_____
Increasing share of existing markets	_____
Meeting customer requirements	_____
Anticipating regulatory requirements	_____

22a. Do you require producers/suppliers delivering to your plant to follow certain food quality guidelines over and above federal/provincial regulations? *(Please check one)*

Yes ☐ *Proceed to Question 22b*
No ☐ *Proceed to Question 23a*

22.b Which guidelines do you require them to follow? *(Please provide a short description)*

____
____
____
____

Food Safety and Quality System Inspections and Audits

23a. Do your customers require that your plant be inspected and/or audited for the food safety and/or quality systems you employ?

Yes ☐ *Proceed to Question 23b*

No ☐ *Proceed to Question 24a*

23b. Who is your plant inspected/audited by *(Please check all that apply)*

Your customers themselves ☐

Third party body ☐

Other *(specify)*: ☐

23c. How frequently is the plant inspected? *(Please check one)*

Every six months ☐
Every year ☐
Every two years ☐
Less than every two years ☐

24a. Do you ever undertake internal audits of your food safety and/or quality systems?

Yes ☐ *Proceed to Question 24b*

No ☐ *Proceed to Question 25*

24b. How frequently do you undertake such internal audits? *(Please check one)*

Every six months ☐
Every year ☐
Every two years ☐
Less than every two years ☐

Traceability Systems in your Supply Chain

These questions relate to the systems of traceability you employ in your plant. By traceability we mean the systems you employ in order to trace product lots and/or product attributes from the inputs you buy through to the markets you supply.

25. At the current time, have you implemented or do you plan to implement, a system of product traceability in the plant?

Yes ☐ *Proceed to Question 26*

No ☐ *Proceed directly to Question 48*

26. How important were the following reasons for your decision or plans to implement a system of product traceability system in the plant?

	Very important	Important	Neither important or unimportant	Unimportant	Very unimportant
To reduce product liability	☐	☐	☐	☐	☐
To meet current regulatory requirements	☐	☐	☐	☐	☐
To meet anticipated future regulatory requirements	☐	☐	☐	☐	☐
To reduce the risk of a product problem occurring	☐	☐	☐	☐	☐
To meet current consumer requirements	☐	☐	☐	☐	☐
To reduce the impact when a product recall occurs	☐	☐	☐	☐	☐
To meet anticipated future customer requirements	☐	☐	☐	☐	☐
Reduce customer complaints	☐	☐	☐	☐	☐
Recommended by trade/industry organization	☐	☐	☐	☐	☐
Access new markets	☐	☐	☐	☐	☐
Obtain higher price for products	☐	☐	☐	☐	☐
I think it is good practice	☐	☐	☐	☐	☐
Increase share of current markets	☐	☐	☐	☐	☐
Reposition products in current markets	☐	☐	☐	☐	☐
Reduce costs of production or improved yield	☐	☐	☐	☐	☐
So I can worry less about a product recall occurring	☐	☐	☐	☐	☐
Reduce risk of product recalls	☐	☐	☐	☐	☐
Improve inventory management	☐	☐	☐	☐	☐
Improve coordination of supply chain	☐	☐	☐	☐	☐
Reduce spoilage or improved freshness	☐	☐	☐	☐	☐

27. Which product attributes are currently being traced in the plant *(Please check all that apply)*.

General product safety	☐	Non-GMO	☐
Organic	☐	Lactose-free	☐
Antibiotic-free	☐	BST -free	☐
Allergen-free	☐	No preservatives	☐
Unpasteurized	☐	Environmentally-sustainable process	☐
Other *(specify)*: _______	☐	Other *(specify)*: _______	☐

28. Are records for traceability purposes maintained manually or by computer?

Computer/electronics ☐ *Proceed to Question 29*

Manually ☐ *Proceed to Question 30*

29. Did your firm purchase/develop any software specific to your traceability system?

Yes ☐ No ☐

30. To what extent did you have to reconfigure your production system to facilitate the implementation of your traceability system?

Major reconfiguration ☐
Minor reconfiguration ☐
No reconfiguration ☐

31. To what extent did you have to reorganise personnel duties and/or responsibilities to facilitate the implementation of your traceability system?

Major reorganisation ☐
Minor reorganisation ☐
No reorganisation ☐

32a. Are you able to trace your products down the supply chain to the retail level?

Yes ☐ *Proceed to Question 33*

No ☐ *Proceed to Question 32b*

32b. Are you able to trace your products to the next level down the supply chain?

Yes ☐ No ☐

33. Are you able to trace your supply of milk back to named individual or groups of farmers?

Yes ☐ No ☐

34a. In which year was your traceability system implemented?

____

34b. What is the smallest unit to which you can trace any or all of your final product(s)?

Four or more days production ☐
Two or three days production ☐
Individual days production ☐
Multiple batches within a single days production ☐
Other *(specify)*: ______________________________ ☐

34c. What percentage of your plant's production can you trace back to this level?

____________%

35. Can you provide details of the maximum level to which you can trace back your major final products? *(Please specify product in each case)*

Product *(Specify)*	**Four or more days production**	**Two or three days production**	**Individual day's production**	**Multiple batches within a day**
____________	☐	☐	☐	☐
____________	☐	☐	☐	☐
____________	☐	☐	☐	☐
____________	☐	☐	☐	☐
____________	☐	☐	☐	☐

36. Do you undertake periodic tests to ensure the system of product traceability operates effectively?

Yes ☐ *Proceed to Question 37*

No ☐ *Proceed directly to Question 38*

37. How frequently do you undertake such tests?

Weekly ☐
Monthly ☐
Every three months ☐
Every six months ☐
Annually ☐
Every two years ☐
Other (*specify*): ____________ ☐

38. Has your traceability system been verified through an external audit?

Yes ☐ No ☐

39a. Did you have any product recalls/withdrawals in the three years previous to implementing your traceability system?

Yes ☐ *Proceed to Question 39b*

No ☐ *Proceed to Question 39c*

39b. How many recalls/withdrawals did you have in the three years previous to implementing your traceability system?

____

39c. Have you had any product recalls/withdrawals since implementing your traceability system?

Yes ☐ *Proceed to Question 39d*

No ☐ *Proceed to Question 40*

39d. If yes, how many recalls/withdrawals have you had since implementing your traceability system?

____

Costs and Benefits of your Traceability System

40. How significant were/are each of the following problems in the implementation, maintenance and/or operation of the product traceability system in the plant?

	Very important	Important	Neither important or unimportant	Unimportant	Very unimportant
Need to retrain production/ supervisory staff	☐	☐	☐	☐	☐
Need to retrain managerial/ administration staff	☐	☐	☐	☐	☐
Attitude/motivation of production/ supervisory staff	☐	☐	☐	☐	☐
Attitude/motivation of managerial/ administration staff	☐	☐	☐	☐	☐
Flexibility of production processes Ability to manufacture new products	☐	☐	☐	☐	☐
Takes production/supervisory staff away from other duties	☐	☐	☐	☐	☐
Takes management/administrative staff away from other duties	☐	☐	☐	☐	☐
Availability of reliable consultants	☐	☐	☐	☐	☐
Support and co-operation of suppliers	☐	☐	☐	☐	☐
Support and co-operation of customers	☐	☐	☐	☐	☐
Lack of clear standards for traceability systems	☐	☐	☐	☐	☐
Number of product attributes/processes to be recorded	☐	☐	☐	☐	☐
Development and availability of appropriate software	☐	☐	☐	☐	☐
Other *(specify)*: ___________________	☐	☐	☐	☐	☐

41. How important are/were each of the following potential costs of implementing and maintaining/ operating a system of product traceability in the plant?

System implementation

Renovation of plant	☐	☐	☐	☐	☐
Purchase of new equipment	☐	☐	☐	☐	☐
Purchase of new software	☐	☐	☐	☐	☐
External consultants	☐	☐	☐	☐	☐
Production line staff time	☐	☐	☐	☐	☐
Supervisory staff time	☐	☐	☐	☐	☐
Managerial/administrative staff time	☐	☐	☐	☐	☐
External training courses	☐	☐	☐	☐	☐

	Very important	Important	Neither important or unimportant	Unimportant	Very unimportant
Disruption of production	☐	☐	☐	☐	☐
Laboratory testing	☐	☐	☐	☐	☐
Inspections/audits	☐	☐	☐	☐	☐
Other *(specify)*: ____________________	☐	☐	☐	☐	☐
System maintenance/operation					
Production staff time	☐	☐	☐	☐	☐
Supervisory staff time	☐	☐	☐	☐	☐
Managerial/administrative staff time	☐	☐	☐	☐	☐
Upgrading equipment	☐	☐	☐	☐	☐
Upgrading software	☐	☐	☐	☐	☐
Laboratory testing	☐	☐	☐	☐	☐
Monitoring supplies	☐	☐	☐	☐	☐
External training courses	☐	☐	☐	☐	☐
External consultants	☐	☐	☐	☐	☐
Inspections/audits	☐	☐	☐	☐	☐
Other *(specify)*: ____________________	☐	☐	☐	☐	☐

42a. What do you consider to be the most important impediment *within your own plant/company* to achieving traceability of your products through to retail or food service distribution?

____

____

____

____

42b. What do you consider to be the most important impediment *outside of your own plant/company* to achieving traceability of your products through to retail or food service distribution?

____

____

____

____

43. Have you benefited directly from the implementation of a product traceability system in the plant?

Yes ☐ No ☐

44. What impact has the implementation of a system of product traceability in the plant had on each of the following?

	Very positive	Positive	No impact	Negative	Very Negative
Number of product recalls/ withdrawals	☐	☐	☐	☐	☐
Scope of product recalls/withdrawals	☐	☐	☐	☐	☐
Costs in the event of a product recall/ withdrawal	☐	☐	☐	☐	☐
Inventory costs	☐	☐	☐	☐	☐
Production costs	☐	☐	☐	☐	☐
Prices realized for products	☐	☐	☐	☐	☐
How company perceived by commercial customers	☐	☐	☐	☐	☐
How company perceived by regulators	☐	☐	☐	☐	☐
How company perceived by consumers	☐	☐	☐	☐	☐
How company perceived by rest of industry	☐	☐	☐	☐	☐
Ability to access new markets	☐	☐	☐	☐	☐
Ability to increase share of existing markets	☐	☐	☐	☐	☐
Ability to meet customer requirements	☐	☐	☐	☐	☐
Ability to meet regulatory requirements	☐	☐	☐	☐	☐
Levels of product wastage/reworking	☐	☐	☐	☐	☐
Motivation of production/supervisory staff	☐	☐	☐	☐	☐
Motivation of managerial/ administration staff	☐	☐	☐	☐	☐
Other (*specify*): ____________________	☐	☐	☐	☐	☐

45a. Overall, do you consider that your total costs of production are higher or lower as a direct result of implementing a system of product traceability in the plant?

Higher ☐ *Proceed to Question 45b*

Same ☐ *Proceed to Question 46*

Lower ☐ *Proceed to Question 45b*

45b. How much have your production costs increased/decreased as a direct result of implementing a system of product traceability in the plant?

____________%

46. Overall how do the benefits of implementing your traceability system compare to the costs?

Benefits much greater than costs	Benefits greater than costs	Benefits roughly equal to costs	Benefits lower than costs	Benefits much lower than costs
☐	☐	☐	☐	☐

47. How have the costs and benefits of implementing your traceability system differed to your prior expectations?

	Much greater	Greater	No difference	Lower	Much lower
Costs	☐	☐	☐	☐	☐
Benefits	☐	☐	☐	☐	☐

Proceed directly to Question 49

48. Below are a number of potential reasons why dairy processing plants may not have implemented a system of product traceability. Please indicate how important these were in your own decision to not implement system of product traceability.

	Very important	Important	Neither important nor unimportant	Unimportant	Very unimportant
Lack of qualified staff	☐	☐	☐	☐	☐
Other investments considered more important	☐	☐	☐	☐	☐
Lot of changes to our production processes needed before a traceability system could be put in place	☐	☐	☐	☐	☐
Lot of changes to our quality controls needed before a traceability system could be put in place	☐	☐	☐	☐	☐
Implementation of a traceability system impeded by internal budgetary constraints	☐	☐	☐	☐	☐
Problems obtaining external funding to support the implementation of a traceability system	☐	☐	☐	☐	☐
Not sure whether the implementation of a Traceability system would be of any benefit	☐	☐	☐	☐	☐
Current food safety/quality controls considered sufficient to meet our needs	☐	☐	☐	☐	☐
Concerned that a traceability system would reduce our flexibility in production	☐	☐	☐	☐	☐
Other *(specify)*: ___________________	☐	☐	☐	☐	☐

49. Are there any further comments you would like to make?

50. Would you like us to send you a summary of the survey results?

Yes ☐ No ☐

Many thanks for your valuable contribution to this study. Please now return the questionnaire in the enclosed reply-paid envelope.